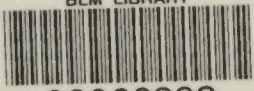


BLM LIBRARY



88066292

**Final
Environmental Impact Statement for the
Atlantic Rim Natural Gas Field
Development Project
Carbon County, Wyoming**

Volume 1 of 2

BLM



TN

880.2

.A52 November 2006

2006

v. 1

c. 2

MISSION STATEMENT

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

BLM/WY/PL-06/021+1310

#77127457

1D88066292

TN
880.2
.A52
2006
v.1
c.2

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

Wyoming State Office

P.O. Box 1828

Cheyenne, Wyoming 82003-1828



In Reply Refer To:

November 27, 2006

1790 (030)

Dear Reader:

This Final Environmental Impact Statement (FEIS) for the proposed Atlantic Rim Natural Gas Development Project (ARPA) is submitted for your review and comment. The FEIS has been prepared to analyze the potential impacts of drilling and production operations of natural gas wells and associated access roads, pipelines, and production facilities proposed by Anadarko E&P Company, LP, and others including Double Eagle Petroleum and Mining Company, and Warren Resources, Inc. The project area is located entirely within Carbon County, Wyoming.

Two technical support documents have also been prepared in conjunction with the FEIS. These documents contain detailed technical information for air quality and ground water modeling. A limited number of technical support documents are available upon request. The technical support documents and the FEIS will also be available for review at the Bureau of Land Management (BLM) offices listed below. The FEIS and its technical support documents may be viewed or downloaded from the BLM website at <http://www.wy.blm.gov/rfo/nepa.htm>.

Bureau of Land
Management
Wyoming State Office
5353 Yellowstone Road
Cheyenne, Wyoming 82009

Bureau of Land
Management
Rawlins Field Office
P.O. Box 2407
Rawlins, Wyoming 82301

Scoping for the ARPA was initiated in 2001 as the "Atlantic Rim Coalbed Methane Project." The proponents modified their proposal to reduce the number of coalbed natural gas (CBNG) wells from the number originally proposed and to develop a limited number of conventional gas wells. The project was re-named to the "Atlantic Rim Natural Gas Development Project" in 2003. The ARPA includes 270,080 acres, with surface ownership of approximately 173,672 acres Federal (64 percent), 14,060 acres State of Wyoming (5 percent), and 82,348 acres of privately held surface (31 percent). At present, there are 132 natural gas wells completed to coal formations within the ARPA. These wells, roads, pipelines, compressors, and other associated facilities were constructed in conjunction with an interim drilling policy, specifically for guiding exploration activities needed to evaluate the natural gas resources within the area.

This FEIS analyzes four alternatives including the proposed action and the no action alternative. The Proposed Action proposes to develop the natural gas resource by drilling up to 2,000 wells of which 1,800 would be drilled to coal beds and 200 to other formations. Based on the current knowledge of the geologic formations and the assumption of one well per well pad, the proposed well spacing would be up to 80 acres per well. Supporting infrastructure including pipelines, roads, and ancillary facilities are proposed. Waste water produced from coalbed natural gas production wells would be disposed of by sub-surface re-injection.

Under the Alternative A, No Action Alternative, the project as proposed would be rejected by the BLM. Existing Atlantic Rim wells could continue to operate as approved and constructed. Alternative D proposed the same number and types of wells, including supporting development as described for the Proposed Action conditioned on monitoring and minimizing the amount of surface disturbance. Alternative C would require the use of development protection measures for sensitive resources and would limit surface disturbance amounts resulting in less well development and recovery of natural gas resources.

The BLM's preferred alternative is Alternative D. Disclosure of the agency's preferred alternative does not imply that this will be the BLM's final decision. Additional information acquired from public comments and BLM internal review may result in the selection of an alternative, or combination of alternatives, to provide the best mix of operational requirements including mitigation measures and best management practices to reduce environmental harm.

If you wish to submit comments on the FEIS, we request that you make them as specific as possible. Comments will be more helpful if they include suggested changes, sources, or methodologies and be considered and included as part of the BLM decision making process.

Comments will be accepted for a 30 day review period starting with the publication of a Notice of Availability of this FEIS in the Federal Register. Please submit your comments in writing to:

David Simons, Project Lead
Bureau of Land Management
Rawlins Field Office
P.O. Box 2407
Rawlins, Wyoming, 82301

You may also submit comments electronically at the address shown below. Please put "Atlantic Rim Natural Gas Development Project" in the subject line.

Atlantic_Rim_EIS_WYMail@blm.gov

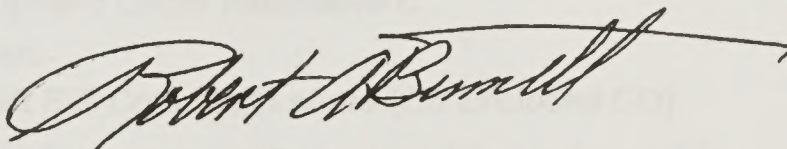
This FEIS was prepared pursuant to the National Environmental Policy Act and other regulations and statutes to address the environmental and socio-economic impacts which could result from the project. This FEIS is not a decision document. Its purpose is to inform the public and interested parties of the BLM's analysis potential impacts associated with implementing the company's drilling proposal and other alternatives.

Freedom of Information Act Considerations: Comments submitted for this FEIS, including the names and street addresses of respondents, will be made available for public review. They may be reviewed by visiting the Rawlins Field Office during regular business hours (8:00 a.m. to 4:30 p.m.), Monday through Friday, except holidays. Individual respondents may request confidentiality. If you wish to withhold your address from public review or from disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your written comment. Such request will be honored to the extent allowed by law. All submissions from organizations or businesses and from individuals identifying themselves as representatives or officials of organizations or businesses will be made available for public inspection in their entirety.

A copy of the FEIS has been sent to affected Federal, State, and local government agencies, and to those persons who have indicated that they wished to receive a copy of the FEIS. If you retain a copy of this FEIS it will assist you with understanding the Record of Decision when it is issued.

If you have questions or need additional information, please contact David Simons, Project Lead, at the Rawlins Field Office, address shown above, or by phone (307) 328-4328

Sincerely,

A handwritten signature in black ink, appearing to read "Robert A. Bennett", with a long horizontal flourish extending to the right.

Robert A. Bennett
State Director

FINAL
ENVIRONMENTAL IMPACT STATEMENT

ATLANTIC RIM
NATURAL GAS FIELD DEVELOPMENT PROJECT

Prepared by

Bureau of Land Management
Rawlins Field Office
Rawlins, Wyoming

November 2006

Executive Summary

Executive Summary

The Department of the Interior (DOI), Bureau of Land Management (BLM) Rawlins Field Office (RFO) has received a proposal from Anadarko E & P Company, LP, as lead proponent for a group of companies including Warren Resources, Inc., Double Eagle Petroleum and Mining Company (Companies), and other natural gas operators (collectively known as the Operators) to develop and remove natural gas resources in south western Carbon County, Wyoming. Operations are proposed for the Atlantic Rim Project Area (ARPA) encompassing 270,080 acres of land located in Townships 13 North to 20 North and Range 89 West to 92 West, south and west of Rawlins, Wyoming. Life of project (LOP) is estimated to run from 30 to 50 years.

The DOI/BLM RFO has determined the proposed project would constitute a major federal action and, therefore, requires the preparation of an environmental impact statement (EIS) in accordance with the National Environmental Policy Act of 1969, as amended (NEPA). This Final EIS (FEIS) replaces the Draft EIS in its entirety and was prepared in accordance with NEPA to assess the environmental consequences of the Operator's proposed action and alternative courses of action. It is intended to provide the public and decision-makers with a complete and objective evaluation of impacts that might occur from the Proposed Action and reasonable alternatives.

The State of Wyoming is a cooperating agency in this EIS with active participation from many agencies including in part the State Planning Office, Wyoming Game and Fish Department, the State Historic Preservation Office, the Wyoming Department of Environmental Quality, and the Wyoming Department of Agriculture. Other cooperating agencies include the Saratoga Encampment Rawlins Conservation District and the Little Snake River Conservation District.

Proposed Action

The Operators proposed to drill and develop up to 2,000 new natural gas wells. Approximately 1,800 wells would be drilled to coals within the Mesaverde Group to develop coalbed natural gas (CBNG) resources. An additional 200 wells would be drilled to access conventional natural gas found in other formations, generally expected to be deeper than the Mesaverde coals. The 2,000 proposed new natural gas wells would be in addition to the 116 ARPA exploration wells already drilled in the interim drilling period.

Proposed well spacing is eight wells per section (80-acre spacing) throughout the project area, but may reduce to four wells per sections (160-acre spacing) depending on the geology and ability of the operators to recover the gas resource. Development and drilling would begin in 2007 and continue for approximately 20 years, with a LOP of 30–50 years. Various drilling—and production—related facilities (e.g., roads, pipelines, water wells, disposal wells, compressor stations, and gas processing facilities) would also be constructed throughout the ARPA.

Scoping

Public and agency scoping was conducted to determine issues relative to the Proposed Action. A scoping notice and informational materials were mailed to potentially interested parties beginning in 2001 under the title "Atlantic Rim Coalbed Methane Project." Subsequently, the

EXECUTIVE SUMMARY

project was re-named the “Atlantic Rim Natural Gas Development Project” in view of the proponents’ request to reduce the number of wells proposed and to develop a limited number of conventional gas wells. All issues identified during scoping and BLM and Interdisciplinary Team reviews were evaluated to identify key issues that drove development of alternatives and the impact analyses. 13 key issues were identified including: Increased traffic on existing county, state, and BLM roads, adverse socio-economic impacts to local communities, impacts to surface water hydrology including increased rates of delivery of sedimentation and salts to the Colorado River system, impacts to groundwater resources, impacts to sensitive soils, impacts to air quality, successful and timely reclamation of disturbed areas, conflicts with livestock management operations, impacts to cultural and historic values within the area including historic trails, impacts to wildlife habitats, impacts to threatened, endangered and sensitive plant and wildlife species, the cumulative effects of drilling and development activities, and potential conflicts between mineral development and recreational activities. Comments to the Draft EIS (DEIS) developed two additional key issues; directional drilling/well spacing, and phased development.

The three action alternatives summarized below meet the Purpose and Need of the proposal but vary in response to the key issues. An alternative considered in depth in the DEIS (Alternative B) has not been carried over to the FEIS. Other alternatives were considered but eliminated from detailed study.

Alternatives

Alternative A - No Action

NEPA regulations require that EIS alternative analyses “include the alternative of no action” [40 CFR 1502.14(d)]. For this analysis, “no action” means that the BLM would reject the Proponents proposal and the proposed activity would not take place. Development activities and operations approved under EAs during the interim drilling period would continue as approved.

Alternative C

Under Alternative C the operators would be approved to develop natural gas resources from the desired target formations but operations would be subject to development protection measures (DPM) in those areas with sensitive or crucial resource values (as detailed in appendix L), likely resulting in fewer acres of disturbance and reduced road density on federal lands. Generally DPMs focus on surface disturbance limits, selection of facility locations, drilling, and construction practices and, in some cases, no surface occupancy. Examples of such areas where DPMs would be applied are wildlife and fish habitat and areas with sensitive soils. As an end product, geographic information system (GIS) layers would be available to operators for development of site-specific proposals for their planning of the annual program.

Alternative D - BLM Preferred Alternative

The goal of this alternative is to minimize surface disturbance while optimizing natural gas recovery. Annual planning between the operators and the BLM would be a key component of this alternative. The annual planning would require the operators to submit to the BLM their proposed plan of operation for the forthcoming year. The BLM would then work with the operators at a site-specific level to minimize surface disturbance by applying the appropriate

EXECUTIVE SUMMARY

lease stipulations, conditions of approval, best management practices, and any other measures deemed necessary to minimize surface disturbance and still allow for the recovery of natural gas.

Coalbed and conventional natural gas resources would be developed, while reclamation activities stabilize disturbed soils and vegetation communities. For the overall Atlantic Rim area, no more than 7,600 acres of the project area would be disturbed and unsuccessfully reclaimed at any time. For the overall Atlantic Rim area, there would be a 6.5 acres/wellpad short-term disturbance goal (2.8% of the ARPA). Those areas designated as "Category A" would have a short-term disturbance goal of less than 6.5 acres per well pad. Category A, as depicted on map M-7, includes areas with sensitive fish populations, and crucial wildlife habitats, and unique vegetation communities, and is about 72,200 acres in extent.

Environmental Impacts

Geology / Minerals / Paleontology

No significant effects are anticipated for these resources under any of the action alternatives (Proposed Action and Alternatives C and D). The purpose of this proposal is to remove and market natural gas resources. These resources would be permanently depleted.

Air Quality

Air quality impacts from the project would occur from pollutants emitted during construction and production operations. The assessment of project potential impacts included both a near-field and a far-field analysis. The near-field analysis assessed direct project impacts in the immediate vicinity of project activities resulting from construction or production reflective of maximum emissions. The far-field analysis assessed potential impacts from field-wide project emissions at in-field locations within the ARPA and at far-field locations (i.e., sensitive Class I and Class II areas). The far-field analysis also assessed regional emission sources located with the model domain.

Near-field impacts from action alternatives emissions were shown to be below the applicable Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS). For far-field effects direct visibility impacts from the action alternatives were predicted to be below the "just noticeable visibility change" (1.0 dv) at all sensitive wilderness areas using both the Federal Land Managers' Air Quality Related Values Workgroup (FLAG) and Interagency Monitoring of PROtected Visual Environments (IMPROVE) background visibility data. Project source emissions from the action alternatives would result in an acid neutralizing capacity (ANC) change less than the level of acceptable change (LAC) at analyzed acid-sensitive lakes. The predicted maximum S and N deposition potential impacts from all action alternatives are below the 0.005 kg/ha-yr DAT at all the sensitive PSD Class I and Class II areas. For potential in-field impacts all action alternatives are below applicable ambient air quality standards.

Soils

The revegetation potential of disturbed soils is expected to be low to moderate under all the alternatives. While no biological crusts are mapped or known to exist within the ARPA, some crusts, if they do exist, may be damaged as a result of selecting any of the action alternatives.

EXECUTIVE SUMMARY

Water Resources

Impacts to waterbodies with impairment or threats of impairment to the State of Wyoming's 303d list (Muddy Creek) are expected from the Proposed Action and Alternative D. Impacts to Muddy Creek under Alternative C would not likely be significant.

Salinity loading in run-off would increase above background conditions for the Proposed Action and Alternative D. Under Alternative C salt loads would be measurably higher but are not expected to be significant.

Under the Proposed Action and Alternative D changes in hydrologic function in wetlands would occur and indirect impacts could be significant. Direct impacts are expected to occur but not be significant. For Alternative C, direct and indirect impacts are not likely to be significant. Changes in streamflow characteristics would occur under any of the action alternatives and indirect effects could be significant.

For Proposed Action and Alternative D changes in geomorphology due to increased surface run-off, erosion, and increased sediment loads would occur in localized areas and cumulative impacts would be significant. Impacts are not likely to be significant under Alternative C. The Standard for Healthy Rangelands for water resources would continue to fail in areas due to indirect impacts and would be significant for any of the action alternatives.

Groundwater

Under all of the action alternatives, impacts to wells, seeps and springs emanating from the upper Mesaverde Group are expected to be significant due to coalbed dewatering. In addition short-term reductions in flows to artesian wells are expected. Groundwater quality is not likely to be significantly diminished under any of the alternatives.

Range and Other Land Uses

Significant impacts from changes in animal unit months (AUMs), livestock mortality, and disturbance of livestock grazing operations and facilities are expected under the Proposed Action and Alternative D. Under Alternative C, impacts are expected to be somewhat reduced due to reduced surface disturbance and implementation of development protection measures.

Vegetation

Effects from increased erosion from roads on moderate to steep slopes and alkali sage communities prone to erosion would result in long-term loss of productivity with significant effects for the Proposed Action and Alternative D.

Indirect effects from erosion and altered run-off patterns from adjacent uplands would have significant impacts for riparian communities under the Proposed Action and Alternative D. Effects are not expected to be significant under Alternative C. Long-term loss of shrubs, including Wyoming and alkali sagebrush sites, is expected to have significant impacts under the Proposed Action and Alternative D. Reduced surface disturbance on federal lands and treatment of roads would result in lower impacts to vegetation and may not be significant if overall browse use rates remain at moderate levels under Alternative C.

EXECUTIVE SUMMARY

For those aspen and mountain shrub communities that have failed Rangeland Health Standards, additional disturbance from development would exacerbate the failed standard, resulting in increased difficulty in meeting the Standard and corresponding significant effects.

The potential for the spread or new infestations of weeds on disturbed sites is high to very high, although impacts would not exceed the significance criteria for Alternative D and the Proposed Action. The possibility of reduced surface disturbance and utilization of development protection measures on federal lands could result in reduced spread and infestation of weeds under Alternative C.

Wildlife

For the Proposed Action and Alternative D, impacts on shrub-dependant songbird nesting habitats would be significant. Under Alternative C, impacts are not expected to be significant. Impacts to greater sage-grouse and Columbian sharp-tailed grouse would be significant under all the action alternatives. For big game, including mule deer and elk, significant effects are expected under all the action alternatives.

Impacts to threatened and endangered, proposed and candidate species, other sensitive species (other than greater sage-grouse and sharp-tailed grouse), and raptors are not expected to be significant under any of the action alternatives. Impacts to threatened and endangered fishes occurring downstream of the ARPA are not expected to occur. Significant impacts to BLM sensitive fishes are expected under the Proposed Action and Alternative D in Muddy Creek. Under Alternative C significant impacts are not expected.

Recreation

Under all the action alternatives displacement of wildlife and the loss of a naturally-appearing setting would make the ARPA less desirable for hunting or wildlife viewing. Visitors would be displaced and impacts would be significant. Impacts to scenery, noise, dust, and human activity would reduce the ARPA's desirability as a place to camp significantly under all the action alternatives.

Visual Resources

For pleasure driving and mountain biking, impacts would be significant for the Proposed Action and Alternative D. Impacts would not be significant under Alternative C. Management objectives for Visual Resource Management (VRM) Class III viewsheds would be exceeded under Alternative D and the Proposed Action. Management objectives would not be exceeded under Alternative C.

Cultural Resources

Impacts to cultural resources as a result of construction activities could impact an estimated 126 sites under all the action alternatives. Reduced visual impacts to settings, where they contribute to site eligibility for historic trails, is expected to be less under Alternative C compared to the Proposed Action and Alternative D.

EXECUTIVE SUMMARY

Socioeconomics

Economic Effects. Economic impacts of natural gas development and production would be largely positive under the action alternatives. Based on the assumptions used for this assessment, natural gas development would enhance regional economic conditions and generate substantial local, state and federal tax and royalty revenues. Economic benefits would be similar for the Proposed Action and Alternatives D. Alternative C would likely result in reduced income and revenue from the gas. Drilling expenditures could be higher for individual wells under Alternative C than the Proposed Action and Alternative D, based on the various development protection measures that might apply on federal lands. Comments to the DEIS from the proponents assert that Alternative C may not be economically feasible and would not result in full development and extraction of the natural gas resource. Economic benefits to leaseholders would be less under Alternative C.

Direct expenditures for drilling/field development are anticipated to be \$981 million, although Alternative C costs would likely be higher, depending on development protection measures. Economic impacts from drilling/field development are expected to be \$1.25 billion with lesser income for Alternative C. For the Proposed Action and Alternative D, 578 average annual jobs are predicted. Under Alternative C, fewer jobs could occur from a corresponding reduction in well numbers. A total of \$6.4 billion in total economic impacts related to production are expected for Alternative D and the Proposed Action. Less revenue could be realized under Alternative C. Impacts to other economic activities within the ARPA include the potential for reductions in the grazing, recreation, and hunting income from the Proposed Action and Alternative D, although disturbance limits may reduce negative effects on grazing and recreation activities. Alternative C is similarly expected to have a reduced impact on these activities.

Peak year drilling and production employment is predicted at 1,490 jobs for the Proposed Action and Alternative D. Peak year population impacts are estimated at about 1,100 people and peak year housing demand at 440 units for both alternatives. For Alternative C, effects would be reduced if less wells are drilled due to development protection measures or if the alternative proves to be uneconomic or to not fully remove the natural gas resource.

Local government facility and service demands are expected to be generally the same for all three action alternatives. Most local government facilities have excess capacity, while some services may need to expand to accommodate growth. County and special district revenue should be adequate to address development needs, but may lag at the time that development—related demand occurs. Municipalities which do not receive royalties, depletions, or similar mineral extraction revenues may not receive direct project related income in sufficient amounts to offset the costs of needed expansion in some cases.

Specific amounts of revenue anticipated are detailed in chapter 4, section 12. For all the various revenue sources, the Proposed Action and Alternative D are expected to have similar effects. Revenues under Alternative C are expected to be less, depending on the effects of development protection measures on the number of wells drilled and gas extracted.

Transportation

Specifics of increased traffic levels are detailed in chapter 4. Average annual daily travel levels would increase for Carbon County Road (CCR) 605N (20 Mile Road), CCR 608 (Wild Cow Road), CCR 501 (Cherry Grove Road), Interstate 80, WY 789, and WY 70 under the Proposed

EXECUTIVE SUMMARY

Action and Alternative D. Increased traffic levels would be lower under Alternative C depending upon the impacts of development protection. Impacts to county roads would include additional maintenance costs, offset by increased property tax revenues from production, with the possibility of a lag time between the need for work and the realization of revenue. There is a history of cooperative action between the companies and the Carbon County Road and Bridge Department that may off-set this effect.

Health and Safety

The risk of industrial injuries would occur under all three action alternatives. If less wells are drilled under Alternative C, there would be a correspondingly reduced risk of hazards. The potential for hazardous material spills/exposure would be the same for the Proposed Action and Alternative D, and somewhat reduced under Alternative C.

Noise

For all alternatives, noise levels associated with drilling, field development, and operations activities may temporarily exceed the threshold USEPA average 24-hour noise level of 55 dBA at specific locations within the ARPA, but the lack of year-round occupied human residences and the low level of non project-related human occupation of the project area would result in minimal noise impacts to persons other than project employees. Although noise impacts associated with compression facilities would be long term in duration, these same factors, absence of human residences and low levels of human occupation, would result in minimal compression facility noise impacts. Noise levels would be similar for the Proposed Action and Alternatives C and D, except that noise disturbances would likely occur at fewer locations under Alternative C if resource protection measures resulted in fewer wells being drilled.

Table of Contents

ATLANTIC RIM NATURAL GAS PROJECT FINAL EIS

TABLE OF CONTENTS

Chapter 1 – Purpose and Need

1.1	Introduction	1-1
1.2	History of Development	1-1
1.2.1	Project Location and Ownership	1-7
1.2.2	Project Description.....	1-7
1.3	Purpose of and Need for Action.....	1-8
1.4	Relationship to Policies, Plans, and Programs	1-9
1.4.1	Conformance with the Great Divide Resource Area Management Plan EIS and Record of Decision	1-9
1.4.1.1	Management Objectives	1-9
1.4.1.2	Management Actions.....	1-9
1.4.2	Relationship to Other Plans and Documents.....	1-10
1.5	Authorizations and Permits.....	1-12
1.6	Public Participation.....	1-14
1.7	Issues and Concerns.....	1-15
1.8	Issues that Drive Alternative Development	1-20

Chapter 2 – Alternatives Including the Proposed Action

2.1	Introduction	1
2.2	Alternatives Description.....	1
2.2.1	The Proposed Action	1
2.2.2	Alternative A (No Action).....	3
2.2.3	Alternative C	3
2.2.4	Alternative D—the BLM's Preferred Alternative	7
2.3	Comparison of Alternatives	10
2.3.1	Features Common to All Action Alternatives	10
2.3.2	Features Unique To Action Alternatives	10
2.4	Alternatives Considered and Eliminated from Detailed Study	11
2.4.1	3,880 Natural Gas Wells from 3,880 Well Locations	11
2.4.2	Directional Drilling.....	11

TABLE OF CONTENTS

2.4.3	Produced Water Disposal and Treatment Options	11
2.4.4	Alternative B	12

Chapter 3 – Affected Environment

3.1	Geology, Mineral, and Paleontology Resources	3-2
3.1.1	Geology Resources	3-2
3.1.1.1	Regional Geologic Overview	3-2
3.1.1.2	Quaternary Deposits.....	3-6
3.1.1.3	Geologic Hazards.....	3-8
3.1.2	Mineral Resources	3-9
3.1.2.1	Locatable Minerals	3-10
3.1.2.2	Leasable Minerals	3-10
3.1.3	Paleontologic Resources	3-13
3.2	Climate and Air Quality.....	3-14
3.2.1	Climate	3-14
3.2.2	Air Quality	3-17
3.3	Soils	3-22
3.3.1	Project Area Soils	3-23
3.3.2	Project Area Soil Limitations	3-23
3.3.2.1	Soil Texture and Strength.....	3-24
3.3.2.2	Soils with Excess Salts.....	3-30
3.3.2.3	Erosion Potential	3-30
3.3.2.4	Reclamation Potential.....	3-30
3.3.2.5	Biological Soils Crusts	3-30
3.3.3	Existing Soil Disturbances	3-33
3.4	Water Resources.....	3-33
3.4.1	Climate and Precipitation	3-36
3.4.2	Surface Water Bodies	3-38
3.4.2.1	Colorado River Basin.....	3-41
3.4.2.2	Great Divide Basin.....	3-43
3.4.2.3	Missouri River Basin.....	3-44
3.4.3	Surface Water Rights.....	3-44
3.4.4	Surface Water Quality.....	3-46
3.4.4.1	Baseline Water Quality Data.....	3-48
3.4.4.2	Waterbodies with Impairments or Threats	3-52
3.4.4.3	Salinity Issues in the Colorado River Basin	3-58
3.4.4.4	Current Pod Conditions	3-58
3.4.4.5	Surface Discharge of Produced Water at the Cow Creek Pod	3-59
3.4.5	Groundwater	3-59
3.4.5.1	Groundwater Location and Quantity	3-59
3.4.5.2	Groundwater Quality.....	3-63
3.4.5.3	Springs and Flowing Wells	3-66
3.5	Vegetation.....	3-68
3.5.1	Primary Vegetation Cover Types	3-68
3.5.1.1	Mountain Big Sagebrush Cover Type and Subtype Inclusions.....	3-70

TABLE OF CONTENTS

3.5.1.2	Wyoming Big Sagebrush and Wyoming Big Sagebrush/Bitterbrush Cover Types	3-71
3.5.1.3	Alkali Sagebrush Cover Type	3-73
3.5.1.4	Basin Big Sagebrush Cover Type	3-73
3.5.1.5	Juniper Woodland Cover Type	3-74
3.5.1.6	Aspen Woodland Cover Type	3-75
3.5.1.7	Greasewood and Greasewood/Basin Big Sagebrush Cover Types	3-76
3.5.1.8	True Mountain Mahogany and Serviceberry Cover Types	3-76
3.5.1.9	Saltbush Steppe Cover Type	3-77
3.5.1.10	Silver Sagebrush/Bitterbrush/Rabbitbrush Cover Type	3-77
3.5.1.11	Riparian Cover Types	3-77
3.5.2	Noxious and Invasive Weeds	3-79
3.6	Range Resources	3-81
3.7	Fish and Wildlife	3-84
3.7.1	Wildlife	3-84
3.7.1.1	Wildlife Habitats	3-85
3.7.1.2	Big Game	3-85
3.7.1.3	Upland Game Birds	3-94
3.7.1.4	Raptors	3-97
3.7.1.5	Combinations of Wildlife Concerns	3-98
3.7.2	Fish	3-98
3.8	Special Status Plant, Wildlife and Fish Species	3-102
3.8.1	Threatened, Endangered, Proposed, or Candidate Species of Plants, Wildlife and Fish	3-102
3.8.1.1	Plant Species	3-103
3.8.1.2	Wildlife Species	3-104
3.8.1.3	Amphibian Species	3-106
3.8.1.4	Fish Species	3-106
3.8.2	Sensitive Plant, Wildlife, and Fish Species	3-108
3.8.2.1	Sensitive Plant Species	3-108
3.8.2.2	Sensitive Wildlife Species	3-110
3.8.2.3	Sensitive Fish Species	3-112
3.9	Recreation Resources	3-115
3.9.1	Recreation Resources and Use	3-115
3.9.1.1	Hunting	3-116
3.9.1.2	Fishing	3-117
3.9.1.3	Other Recreation	3-118
3.9.2	Recreation Plans	3-118
3.9.2.1	Great Divide RMP Revision	3-118
3.9.2.2	Carbon County Land Use Plan	3-119
3.10	Visual Resources	3-119
3.11	Cultural and Historical Resources	3-122
3.11.1	Cultural Chronology of Area	3-122
3.11.1.1	Paleoindian Period	3-122
3.11.1.2	Archaic Period	3-122

TABLE OF CONTENTS

3.11.1.3	Late Prehistoric Period	3-123
3.11.1.4	Proto-Historic Period	3-124
3.11.1.5	Historic Period	3-124
3.11.2	Summary of Extant Cultural Resources	3-124
3.11.3	Site Types.....	3-126
3.11.4	Excavation Data.....	3-128
3.11.5	Historic Sites.....	3-128
3.11.6	Summary	3-132
3.12	Socioeconomics	3-132
3.12.1	Economic Conditions	3-133
3.12.1.1	Oil and Gas Activity	3-136
3.12.1.2	Economic Activities in the Vicinity of the Proposed Action	3-137
3.12.2	Population.....	3-137
3.12.3	Housing Resources	3-139
3.12.3.1	Baggs/Dixon Area	3-139
3.12.3.2	Wamsutter.....	3-140
3.12.3.3	Rawlins.....	3-140
3.12.4	Community Facilities and Services	3-140
3.12.4.1	Carbon County	3-140
3.12.4.2	Rawlins.....	3-140
3.12.4.3	Baggs Area	3-141
3.12.4.4	Wamsutter Area	3-141
3.12.4.5	Carbon County School District #1	3-142
3.12.5	Local Government and State Government Revenues	3-142
3.12.5.1	Ad Valorem Property Tax	3-142
3.12.5.2	Sales and Use Tax	3-143
3.12.5.3	Severance Taxes	3-143
3.12.5.4	Federal and State Mineral Royalty Distributions	3-143
3.12.6	Local Attitudes, Opinions, and Lifestyles.....	3-143
3.12.7	Environmental Justice.....	3-145
3.13	Transportation	3-146
3.13.1	Highway Access to the Project Site.....	3-146
3.13.2	County Road Access to and within the Project Area	3-146
3.13.3	BLM Roads within the Project Area.....	3-148
3.14	Health and Safety.....	3-148
3.15	Noise.....	3-149
3.16	Wild Horses.....	3-149
3.17	Special Management Areas	3-150
3.17.1	Cow Butte/Wild Cow Area.....	3-150
3.17.2	Upper Muddy Creek Watershed/Grizzly Area	3-152
3.17.3	Sand Hills ACEC and Proposed JO Ranch Expansion.....	3-153
3.17.4	Red Rim/Daley Area	3-153

TABLE OF CONTENTS

Chapter 4 – Analysis of Environmental Consequences

4.1	Geology, Mineral, and Paleontology Resources	4-2
4.1.1	Introduction.....	4-2
4.1.1.1	Geology.....	4-2
4.1.1.2	Mineral Resources.....	4-2
4.1.1.3	Paleontology.....	4-3
4.1.2	Impact Significance Criteria	4-3
4.1.3	Direct and Indirect Impacts	4-4
4.1.3.1	Proposed Action	4-4
4.1.3.2	Alternative A (No Action)	4-4
4.1.3.3	Alternative C.....	4-4
4.1.3.4	Alternative D.....	4-5
4.1.4	Impacts Summary.....	4-5
4.1.5	Additional Mitigation Measures	4-5
4.1.5.1	Geology.....	4-5
4.1.5.2	Minerals.....	4-5
4.1.5.3	Paleontology.....	4-5
4.2	Air Quality	4-6
4.2.1	Impact Significance Criteria	4-6
4.2.2	Direct and Indirect Impacts	4-7
4.2.2.1	Analysis Assessment of Direct and Indirect Impacts.....	4-7
4.2.2.2	Proposed Action	4-12
4.2.2.3	Alternatives A, C, and D	4-15
4.2.3	Air Quality Monitoring and Mitigation.....	4-15
4.2.3.1	Monitoring	4-15
4.2.3.2	Mitigation.....	4-16
4.3	Soils	4-16
4.3.1	Introduction.....	4-16
4.3.2	Impact Significance Criteria	4-16
4.3.3	Direct and Indirect Impacts	4-17
4.3.3.1	Proposed Action	4-17
4.3.3.2	Alternative A (No Action)	4-18
4.3.3.3	Alternative C.....	4-18
4.3.3.4	Alternative D.....	4-19
4.3.4	Impacts Summary.....	4-19
4.3.5	Additional Mitigation Measures	4-19
4.4	Water Resources.....	4-20
4.4.1	Introduction.....	4-20
4.4.1.1	Surface Water Impacts	4-21
4.4.1.2	Groundwater Impacts	4-21
4.4.1.3	Assumptions for Analysis.....	4-21
4.4.2	Impact Significance Criteria	4-24
4.4.2.1	Surface Water Significance Criteria	4-24
4.4.2.2	Groundwater Significance Criteria	4-25
4.4.3	Direct and Indirect Impacts	4-25
4.4.3.1	Direct and Indirect Impacts Common to All Alternatives	4-25
4.4.3.2	Proposed Action Impacts.....	4-42

TABLE OF CONTENTS

4.4.3.3	Alternative A (No Action)	4-45
4.4.3.4	Alternative C.....	4-45
4.4.3.5	Alternative D.....	4-48
4.4.4	Impacts Summary for all Action Alternatives	4-49
4.4.5	Additional Mitigation Measures	4-49
4.5	Vegetation and Wetlands	4-50
4.5.1	Introduction.....	4-50
4.5.2	Impact Significance Criteria	4-50
4.5.3	Direct and Indirect Impacts	4-51
4.5.3.1	Direct and Indirect Impacts Common to All Alternatives	4-51
4.5.3.2	Proposed Action	4-53
4.5.3.3	Alternative A (No Action)	4-56
4.5.3.4	Alternative C.....	4-56
4.5.3.5	Alternative D.....	4-59
4.5.4	Impacts Summary.....	4-59
4.5.5	Additional Mitigation Measures	4-60
4.6	Rangeland Resources	4-60
4.6.1	Introduction.....	4-60
4.6.2	Impact Significance Criteria	4-60
4.6.3	Direct and Indirect Impacts	4-61
4.6.3.1	Direct and Indirect Impacts Common to All Alternatives	4-61
4.6.3.2	Proposed Action	4-62
4.6.3.3	Alternative A (No Action)	4-63
4.6.3.4	Alternative C.....	4-64
4.6.3.5	Alternative D.....	4-65
4.6.4	Impacts Summary.....	4-65
4.6.4.1	The Proposed Action.....	4-65
4.6.4.2	Alternative A (No Action)	4-65
4.6.4.3	Alternative C.....	4-66
4.6.4.4	Alternative D.....	4-66
4.6.5	Additional Mitigation Measures	4-67
4.6.5.1	The Proposed Action.....	4-67
4.6.5.2	Alternative A (No Action)	4-67
4.6.5.3	Alternative C.....	4-67
4.6.5.4	Alternative D.....	4-67
4.7	Wildlife	4-68
4.7.1	Introduction.....	4-68
4.7.2	Impact Significance Criteria	4-68
4.7.3	Direct and Indirect Impacts	4-69
4.7.3.1	Direct and Indirect Impacts Common to All Alternatives	4-69
4.7.3.2	Proposed Action	4-78
4.7.3.3	Alternative A (No Action)	4-80
4.7.3.4	Alternative C.....	4-80
4.7.3.5	Alternative D.....	4-82
4.7.4	Impacts Summary.....	4-84
4.7.4.1	Proposed Action	4-84
4.7.4.2	Alternative C.....	4-84
4.7.4.3	Alternative D.....	4-85

TABLE OF CONTENTS

4.7.5	Additional Mitigation Measures	4-85
4.8	Special Status Plant, Wildlife, and Fish Species.....	4-86
4.8.1	Introduction.....	4-86
4.8.2	Impact Significance Criteria	4-86
4.8.3	Direct and Indirect Impacts	4-86
4.8.3.1	Direct and Indirect Impacts Common to All Alternatives	4-86
4.8.3.2	Proposed Action	4-87
4.8.3.3	Alternative A (No Action)	4-94
4.8.3.4	Alternative C.....	4-95
4.8.3.5	Alternative D.....	4-96
4.8.4	Impact Summary.....	4-96
4.8.4.1	Proposed Action	4-96
4.8.4.2	Alternative C.....	4-97
4.8.4.3	Alternative D.....	4-97
4.8.5	Additional Mitigation Measures	4-97
4.9	Recreation Resources.....	4-98
4.9.1	Introduction.....	4-98
4.9.2	Impact Significance Criteria	4-99
4.9.3	Direct and Indirect Impacts	4-99
4.9.3.1	Proposed Action	4-100
4.9.3.2	Alternative A (No Action)	4-102
4.9.3.3	Alternative C.....	4-102
4.9.3.4	Alternative D.....	4-104
4.9.4	Additional Mitigation Measures	4-105
4.10	Visual Resources	4-105
4.10.1	Introduction.....	4-105
4.10.2	Impact Significance Criteria	4-106
4.10.3	Direct and Indirect Impacts	4-107
4.10.3.1	Proposed Action	4-107
4.10.3.2	Alternative A (No Action)	4-110
4.10.3.3	Alternative C.....	4-110
4.10.3.4	Alternative D.....	4-110
4.10.4	Summary of Impacts.....	4-113
4.10.5	Additional Monitoring and Mitigation Measures.....	4-113
4.11	Cultural Resources.....	4-116
4.11.1	Introduction.....	4-116
4.11.2	Impact Significance Criteria	4-117
4.11.3	Direct and Indirect Impacts	4-118
4.11.3.1	Proposed Action	4-118
4.11.3.2	Alternative A (No Action)	4-118
4.11.3.3	Alternative C.....	4-118
4.11.3.4	Alternative D.....	4-119
4.11.4	Impacts Summary.....	4-119
4.11.5	Additional Mitigation Measures	4-119
4.12	Socioeconomics	4-120
4.12.1	Introduction.....	4-120

TABLE OF CONTENTS

4.12.2	Impact Significance Criteria	4-120
4.12.3	Direct and Indirect Impacts	4-121
4.12.3.1	Proposed Action	4-121
4.12.3.2	Alternative A (No Action)	4-141
4.12.3.3	Alternative C	4-142
4.12.3.4	Alternative D	4-143
4.12.4	Impacts Summary	4-145
4.12.5	Additional Mitigation Measures	4-146
4.13	Transportation	4-146
4.13.1	Introduction	4-146
4.13.2	Impact Significance Criteria	4-147
4.13.3	Direct and Indirect Impacts	4-147
4.13.3.1	Proposed Action	4-147
4.13.3.2	Alternative A (No Action)	4-151
4.13.3.3	Alternative C	4-151
4.13.3.4	Alternative D	4-151
4.13.4	Impact Summary	4-152
4.13.5	Additional Mitigation Measures	4-152
4.14	Health and Safety	4-153
4.14.1	Introduction	4-153
4.14.2	Impact Significance Criteria	4-153
4.14.3	Direct and Indirect Impacts	4-153
4.14.3.1	Proposed Action	4-153
4.14.3.2	Alternative A (No Action)	4-155
4.14.3.3	Alternative C	4-155
4.14.3.4	Alternative D	4-155
4.14.4	Additional Mitigation Measures	4-155
4.15	Noise	4-155
4.15.1	Introduction	4-155
4.15.2	Impact Significance Criteria	4-156
4.15.3	Direct and Indirect Impacts	4-156
4.15.3.1	Proposed Action	4-156
4.15.3.2	Alternative A (No Action)	4-157
4.15.3.3	Alternative C	4-157
4.15.3.4	Alternative D	4-157
4.15.4	Additional Mitigation	4-157
4.16	Wild Horses	4-157
4.17	Special Management Areas	4-158
4.17.1	Introduction	4-158
4.17.2	Direct and Indirect Impacts (Common to All)	4-158
4.17.2.1	Proposed Action	4-158
4.17.2.2	Alternative A (No Action)	4-158
4.17.2.3	Alternative C	4-158
4.17.2.4	Alternative D	4-158
4.17.3	Cow Butte/Wild Cow Area	4-159
4.17.3.1	Direct and Indirect Impacts	4-159

TABLE OF CONTENTS

4.17.3.2	Proposed Action	4-159
4.17.3.3	Alternative A (No Action)	4-159
4.17.3.4	Alternative C	4-159
4.17.3.5	Alternative D	4-160
4.17.4	Upper Muddy Creek Watershed/Grizzly Area	4-160
4.17.4.1	Direct and Indirect Impacts	4-160
4.17.4.2	Proposed Action	4-160
4.17.4.3	Alternative A (No Action)	4-160
4.17.4.4	Alternative C	4-160
4.17.4.5	Alternative D	4-161
4.17.5	Sand Hills ACEC and Proposed JO Ranch Expansion	4-161
4.17.5.1	Direct and Indirect Impacts	4-161
4.17.5.2	Proposed Action	4-161
4.17.5.3	Alternative A (No Action)	4-161
4.17.5.4	Alternative C	4-161
4.17.5.5	Alternative D	4-161
4.17.6	Red Rim/Daley Area	4-162
4.17.6.1	Direct and Indirect Impacts	4-162
4.17.6.2	Proposed Action	4-162
4.17.6.3	Alternative A (No Action)	4-162
4.17.6.4	Alternative C	4-162
4.17.6.5	Alternative D	4-162

Chapter 5 – Cumulative Impacts Analysis

5.1	Past, Existing, and Reasonably Foreseeable Future Activity	5-1
5.1.1	Atlantic Rim Project Area	5-1
5.1.2	Southeastern Sweetwater County/Southwestern Carbon County CIA Area	5-2
5.1.3	Watershed CIA Area	5-3
5.1.4	Regional CIA Area	5-4
5.2	Potential Cumulative Impacts by Resource	5-4
5.2.1	Geology/Minerals/Paleontology	5-4
5.2.2	Climate and Air Quality	5-5
5.2.2.1	Proposed Action Far-Field Cumulative Impacts	5-7
5.2.2.2	Proposed Action In-Field Cumulative Impacts	5-8
5.2.2.3	Alternative A (No Action) Far-Field Cumulative Impacts	5-8
5.2.2.4	Alternatives C and D Far-Field Cumulative Impacts	5-8
5.2.2.5	Unavoidable Adverse Impacts	5-9
5.2.3	Soils	5-9
5.2.4	Water Resources	5-9
5.2.4.1	ARPA Cumulative Impact Analysis Area	5-9
5.2.4.2	Watershed Cumulative Impact Analysis Area	5-10
5.2.5	Vegetation and Wetlands	5-11
5.2.5.1	ARPA Area	5-11
5.2.5.2	Watershed CIA Area	5-13
5.2.6	Range Resources	5-13
5.2.6.1	ARPA Area	5-13
5.2.6.2	Watershed CIA Area	5-14
5.2.7	Wildlife	5-14

TABLE OF CONTENTS

5.2.7.1	Big Game	5-15
5.2.7.2	Greater Sage-Grouse and Columbian Sharp-Tailed Grouse.....	5-17
5.2.7.3	Raptors.....	5-18
5.2.8	Special Status Plant, Wildlife, and Fish Species	5-18
5.2.8.1	Plants	5-18
5.2.8.2	Wildlife.....	5-19
5.2.8.3	Fish	5-19
5.2.9	Recreation Resources	5-19
5.2.10	Visual Resources.....	5-20
5.2.11	Cultural Resources	5-21
5.2.12	Socioeconomic Resources	5-21
5.2.13	Transportation	5-26
5.2.14	Health and Safety	5-26
5.2.15	Noise	5-26

Chapter 6 – Consultation and Coordination

6.1	Public Participation.....	6-1
6.2	List of Preparers.....	6-3

List of Appendices

LIST OF APPENDICES

Appendix A	Interim Drilling Policy
Appendix B	Reclamation Plan
Appendix C	Hazardous Materials Management Plan
Appendix D	Wildlife and Fish Species Lists
Appendix E	Wildlife Monitoring and Protection Plan
Appendix F	Air Quality Technical Support Document, Atlantic Rim Natural Gas Project and the Seminoe Road Gas Development Project, Wyoming
Appendix G	Biological Assessment
Appendix H	Required Best Management Practices
Appendix I	Cultural Resources Management
Appendix J	Best Management Practices for Reducing Non-Point Source Pollution
Appendix K	Plan of Development / Detailed Proposed Action
Appendix L	Resource Concerns and Associated Protection Measures Proposed Under Alternative C
Appendix M	Maps
Appendix N	Draft EIS Comment Letters
Appendix O	BLM Responses to Comments

List of Tables

LIST OF TABLES

Table 1-1.	Current POD Status and General Location.	1-5
Table 1-2.	Surface Ownership within the Atlantic Rim Project Area	1-7
Table 1-3.	Mineral Ownership within the Atlantic Rim Project Area	1-7
Table 1-4.	Status of Well Development within PODs	1-8
Table 1-5.	Federal, State, and County Authorizing Actions	1-12
Table 1-6.	Key Issues and Concerns Identified during the Scoping Period	1-15
Table 2-1.	Brief Comparison of Impacts to Key Issues Across Alternatives	2-14
Table 3-1.	Critical Elements of the Human Environment.....	3-1
Table 3-2.	Surface and Subsurface Geologic Deposits within the Atlantic Rim Project Area.....	3-3
Table 3-3.	Mean Monthly Temperature Ranges and Total Precipitation Amounts	3-14
Table 3-4.	Wind Direction Frequency Distribution for Baggs, Wyoming	3-15
Table 3-5.	Wind Speed and Stability Class Distribution.	3-15
Table 3-6.	Air Pollutant Background Concentrations, Wyoming and National Ambient Air Quality Standards and Prevention of Significant Deterioration Increments	3-17
Table 3-7.	2001 Standard Visual Range Data.....	3-20
Table 3-8.	2001 Measured Acid Deposition Data.....	3-21
Table 3-9.	Background ANC Values for Acid-Sensitive Lakes.	3-21
Table 3-10.	Total Area (Acres) of Soil Factors of Concern within the ARPA	3-26
Table 3-11.	Total Area of Soil Factors of Concern by Subwatersheds within the Project Area.....	3-27
Table 3-12.	BLM Range Rain Gauge Yearly Precipitation Averages.....	3-38
Table 3-13.	Flow Statistics from USGS Gauging Stations Located within and near the ARPA.....	3-40
Table 3-14.	Surface Water Rights within the ARPA.	3-45
Table 3-15.	Surface Water Rights within Major Drainage Areas.	3-45
Table 3-16.	Reservoirs, Lakes, and Ponds in the ARPA.	3-46

LIST OF TABLES

Table 3-17.	Classification of ARPA Surface Waters Based on Protected Uses.....	3-47
Table 3-18.	Classification of Streams in the ARPA	3-47
Table 3-19.	Surface Water Quality in the ARPA.....	3-49
Table 3-20.	Muddy Creek Water Quality.....	3-50
Table 3-21.	2006 303(d) Waterbodies with Impairments or Threats.....	3-55
Table 3-22.	Water-bearing Characteristics of Geologic Formations in the Washakie Basin.....	3-61
Table 3-23.	Pressure Data from Atlantic Rim Groundwater Monitoring Wells	3-62
Table 3-24.	Existing Groundwater Wells in ARPA Vicinity	3-63
Table 3-25.	Major Ionic Composition of Mesaverde Groundwater.....	3-64
Table 3-26.	Isotopic Analysis of Mesaverde Group Coal bed Groundwater	3-64
Table 3-27.	Groundwater Quality for Mesaverde Wells in the ARPA.....	3-65
Table 3-28.	Comparison of Selected Water Quality Parameters between Springs of the Browns Park Formation and the Mesaverde Group	3-66
Table 3-29.	Comparison of Selected Water Quality Parameters in Flowing Wells and Wells Completed in the Almond Formation Coal Seam.	3-68
Table 3-30.	Designated Noxious Weeds in Wyoming	3-80
Table 3-31.	Grazing Allotments and Animal Unit Months (AUMs) Currently Permitted in the Atlantic Rim Project Area.	3-81
Table 3-32.	Population Parameters for Big Game Herd Units within the ARPA.....	3-90
Table 3-33.	Big Game Seasonal Ranges within the Atlantic Rim Project Area.....	3-91
Table 3-34.	Threatened, Endangered, Proposed, Candidate, or Petitioned Species Potentially Present within the Area Administered by the BLM RFO or That May Potentially be Impacted by the Proposed Project	3-102
Table 3-35.	Sensitive Plant Species with Potential to Occur On or Near the Atlantic Rim Project Area.....	3-109
Table 3-36.	Indicators of Hunting Activity by Species in the WGFD Hunt Areas that Include the ARPA, 2002.....	3-116
Table 3-37.	Number of Active Hunters by Species 2003-2005.....	3-117
Table 3-38.	Prehistoric Chronology of the Wyoming Basin	3-122
Table 3-39.	Historic Chronology of the Great Divide Basin and the Washakie Basin	3-124

LIST OF TABLES

Table 3-40.	Summary of Prehistoric and Historic Sites Located in the Atlantic Rim Project Area.....	3-127
Table 3-41.	Economic Estimates for Grazing.....	3-137
Table 3-42.	Economic Estimates for Recreation.....	3-137
Table 3-43.	Population Estimates for Communities near the ARPA.....	3-138
Table 3-44.	Percentage of Minorities in Selected Communities	3-145
Table 3-45.	Percentage of Persons in Poverty in Selected Communities.....	3-145
Table 3-46.	Highway Access Routes to the ARPA.....	3-146
Table 4-1.	Project and Non-Project Emissions (Tons/Year) Included in Far-Field Analysis.	4-10
Table 4-2.	Maximum Predicted Near-Field Impacts from Project Sources–Comparison to Ambient Air Quality Standards, Atlantic Rim Natural Gas Project	4-12
Table 4-3.	Maximum Predicted Near-Field Impacts from Project Sources–Comparison to PSD Increments.....	4-13
Table 4-4.	Maximum Modeled HAP Impacts from Project Sources	4-14
Table 4-5.	Long-term MLE and MEI Cancer Risk Analyses	4-15
Table 4-6.	Average per Well Discharge Rates In Five-Year Increments during the Simulation Period.....	4-38
Table 4-7.	Impacts to Flowing Wells in Year 2050	4-38
Table 4-8	Criteria for Assigning Summary Assessment of Impacts to Visual Resources for the Development Alternatives	4-106
Table 4-9.	Roads in the ARPA Where Users Would Likely See Views of Oil and Gas Facilities under the Proposed Action.....	4-109
Table 4-10.	Estimated Economic Effects of Drilling and Field Development: Proposed Action	4-124
Table 4-11.	Estimated Economic Effects Associated with Proposed Action-Related Production	4-124
Table 4-12.	Combined Proposed Action-Related Drilling and Production Economic Effects	4-125
Table 4-13.	Hiring Status of Proposed Action-Related Employment	4-130
Table 4-14.	First Year and Peak-Year Proposed Action-Related Housing Demand	4-133
Table 4-15.	Estimated Proposed Action-Related Ad Valorem Property Tax Revenues: Carbon County and Affected Special Districts.....	4-136

LIST OF TABLES

Table 4-16.	Estimated Proposed Action-Related Ad Valorem Property Tax Revenues: Carbon County School District #1 and Other School Entities	4-136
Table 4-17.	Federal Mineral Royalty and Wyoming Severance Tax Estimates	4-137
Table 4-18.	Estimated Sales and Use Tax Revenues and Distributions.....	4-138
Table 4-19.	Proposed Action Peak Drilling Year (Year 5) AADT Compared with 2002 AADT and 2012 Projected AADT on Affected Highways	4-149
Table 4-20.	Proposed Action Peak Year (Year 5) AADT on Affected Carbon County Roads	4-150
Table 5-1.	RFD Projects Included in the Cumulative Analysis.....	5-5
Table 5-2.	Estimated Cumulative Surface Disturbance (acres) within Big Game Seasonal Ranges, Included within the ARPA	5-16
Table 5-3.	Cumulative Impacts to Historic Trails	5-21
Table 6-1.	List of BLM Interdisciplinary Reviewers.....	6-3
Table 6-2.	List of Consultant Interdisciplinary Team EIS Preparers	6-4

List of Figures

LIST OF FIGURES

Figure 2-1.	Proposed Action Annual Drilling Assumptions by Well Type	2-3
Figure 3-1.	Wind Rose for the Atlantic Rim Natural Gas Project Area	3-16
Figure 3-2.	Major Ion Composition of Streams in and around the ARPA.....	3-53
Figure 3-3.	Irrigation Suitability of Streams in and around the ARPA	3-54
Figure 3-4.	Carbon County Full- and Part-Time Employment by Place of Work: 1975-2002	3-133
Figure 3-5.	Average Annual Unemployment Rates: 1990-2003	3-134
Figure 3-6.	Total Carbon County Earnings by Place of Work: 1990-2002	3-135
Figure 3-7.	Change in Inflation-Adjusted Carbon County Earnings Contrasted with Wyoming & US: 1990-2002.....	3-135
Figure 3-8.	Carbon County Natural Gas Production: 1995-2003	3-136
Figure 3-9.	Number of Applications for a Permit to Drill in Carbon County: 1995-2003 ..	3-136
Figure 3-10.	Carbon County Population: 1920-2003	3-138
Figure 4-1.	Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of the prevalence of rock substrates at the reach scale from Bower (2005).	4-91
Figure 4-2.	Relative abundance of two length groups of three species within the Upper Muddy Creek watershed as a function of maximum channel unit depth from Bower (2005).	4-92
Figure 4-3.	Example of Erosion Resulting from Concentration of Surface Runoff at Drainage Crossings.....	4-93
Figure 4-4.	Proper Coloration for Visual Resource Management Mitigation.	4-113
Figure 4-5.	Excerpt from Land Use Planning Handbook	4-115
Figure 4-6.	The Visual Contrast Rating Worksheet, Form 8400-4, for the Project would be filled out after an alternative is selected	4-115
Figure 4-7.	Estimated Project -Related Coal Bed Natural Gas Production	4-123
Figure 4-8.	Estimated Proposed Action Total Drilling and Production Employment: Direct, Indirect and Induced	4-128
Figure 4-9.	Components of Total Proposed Action-Related Employment: Direct, Indirect and Induced	4-128
Figure 4-10.	Components of Proposed Action-Related Employment.....	4-131
Figure 4-11.	Proposed Action-Related Peak, Temporary, Single-Status and In-migrant Population.....	4-132

LIST OF FIGURES

Figure 4-12.	Distribution of Peak Proposed Action-Related Population to Communities ...	4-132
Figure 4-13.	Proposed Action-Related Ad Valorem Property Tax Estimates	4-135
Figure 4-14.	Total Ad Valorem Property Tax, Federal Mineral Royalty, Severance Tax, and Sales and Use Tax Revenues Associated with the Proposed Action	4-139
Figure 4-15.	Proposed Action AADT Estimates, Drilling/Field Development and Operations: 2005-2044	4-149

List of Maps

List of Maps

M-1	Project Area Map	1-2
M-2	2001 Project Area	1-3
M-3	Ownership	1-4
M-4	2005 Proposed Action Project Area	1-6
M-5	Mineral Development Projects in the Vicinity	1-11
M-6	ARPA Visible from Main Roads in VRM Class III	2-6
M-7	Alternative D with Category A Mitigation Areas	2-9
M-8	PSD Class I and Class II Sensitive Areas and Sensitive Lakes	3-18
M-9	Top Soils with Excess Salts	3-26
M-10	Hydrologic Unit Code Boundaries	3-28
M-11	Soils with a Severe Road Rating	3-29
M-12	Soils with Elevated Runoff Potential	3-31
M-13	Soils with Poor/Fair Topsoil Ratings	3-32
M-14	Watershed Basins	3-34
M-15	Alternative C – Perennial Surface Waters and Wetlands	3-35
M-16	Surface Waters and Monitoring Stations	3-39
M-17	Threatened or Impaired Streams	3-56
M-18	Sampled Springs and Flowing Wells	3-67
M-19	Vegetation Communities	3-69
M-20	Grazing Allotments	3-83
M-21	Seasonal Pronghorn Ranges and Migrations Routes	3-87
M-22	Big Game Crucial Winter Ranges	3-88
M-23	Seasonal Mule Deer Ranges and Migrations Routes	3-89
M-24	Seasonal Elk Ranges and Migrations Routes	3-92
M-25	Overlapping Crucial Winter Ranges	3-93
M-26	Greater Sage-Grouse Leks	3-95
M-27	Columbian Sharp-Tailed Grouse Leks Nesting and Brood-Rearing Habitat	3-99
M-28	Raptor Nest Locations	3-100
M-29	Overlapping Wildlife Concerns	3-101
M-30	White-Tailed Prairie Dog Colonies	3-105
M-31	Visual Resource Management Classes	3-121
M-32	Historic Trails with Quarter Mile Buffer	3-129
M-33	Federal, State, County, and BLM Roads	3-147
M-34	Special Management Areas Overview	3-151
M-35	Drawdowns within Layer 3 for Year 2030	4-39
M-36	Drawdowns within Layer 1 for Year 2030	4-40
M-37	Drawdowns within Layer 5 for Year 2030	4-41
M-38	Soils with High Runoff Potential	4-46
M-39	Alternative C – Slopes Greater than 25%	4-47
M-40	Alternative C – Resources with Limited Surface Disturbance Mitigation Measure	4-58
M-41	Locations of Successful Hunts	4-103
M-42	Areas Visible from Main Roads in VRM Class III with Slopes <5%	4-112
M-43	Project Area Facility Coloration	4-114
M-44	Far-Field Modeling Domain and NEPA RFD Project Areas	5-6
M-45	Cumulative Impacts Historic Trails	5-22

List of Acronyms/Abbreviations

LIST OF ACRONYMS/ABBREVIATIONS

°F	Degrees Fahrenheit
µeq/L	microequivalents per liter
µg/L	micrograms per liter
µg/m ³	micrograms per cubic meter
µmhos/cm	micromhos per centimeter
AADT	annual average daily traffic
ACEC	Area of Critical Environmental Concern
ac-ft/yr	acre feet per year
ACHP	Advisory Council on Historic Preservation
ACOE	U.S. Army Corps of Engineers
AEPC	Anadarko E & P Company, LP
AIRFA	American Indian Religious Freedom Act of 1978
AJE	annual job equivalents
AML	appropriate management level
amsl	above mean sea level
ANC	acid neutralizing capacity
ANS	artificial nesting structures
AO	Authorized Officer
APD	Application for Permit to Drill
APE	area of potential effect
APLIC	Avian Power Line Interaction Committee
AQRV	Air Quality Related Values
ARNG	Atlantic Rim Natural Gas Project
ARPA	Atlantic Rim Project Area
ARS	Air Resource Specialists
ATT	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> (basin big sagebrush)
ATV	All-terrain vehicle
ATVII	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> and <i>Artemisia tridentata</i> ssp. <i>pauciflora</i> (mountain big sagebrush)
ATW	<i>Artemisia tridentata</i> ssp. <i>Wyomingensis</i> (Wyoming big sagebrush)
AUM	animal unit month
BA	Biological Assessment
BACT	Best Available Control Technology
bbl	barrel
BBS	Breeding Bird Survey

LIST OF ACRONYMS/ABBREVIATIONS

bcf	billion cubic feet
bcf/mile ²	billion cubic feet per square mile
BCLLC	Blankenship Consulting, LLC
BLM	Bureau of Land Management
BMP	Best management practice
B.P.	before present
bpd	barrels per day
bwpd	barrels of water per day
CAAQS	California Ambient Air Quality Standards
CaCO ₃	calcium carbonate
CASTNET	Clean Air Status and Trends Network
CBNG	coal bed natural gas
CCR	Carbon County Road
CCSD	Carbon County School District
CDNST	Continental Divide National Scenic Trail
CD/WII	Continental Divide/Wamsutter II
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIA	cumulative impact analysis
CIRA	Cooperative Institute for Research in the Atmosphere
CO	carbon monoxide
COA	condition of approval
COE	Corps of Engineers
CR	County Road
CRBSCF	Colorado River Basin Salinity Control Forum
CREG	Consensus Revenue Estimating Group
CRM	Coordinated Resource Management
CRP	Conservation Reserve Program
CSU	controlled surface use
CWA	Clean Water Act
CWIN	crucial winter
CWRRRI	Colorado Water Resources Research Institute
CWYL	crucial winter/yearlong

LIST OF ACRONYMS/ABBREVIATIONS

DAT	deposition analysis thresholds
dBA	decibel
DEIS	Draft Environmental Impact Statement
DEM	Digital elevation model
DOI	Department of the Interior
DOT	Department of Transportation
DPM	Development protection measures
dv	deciview
EA	Environmental Assessment
EIA	Energy Information Agency
EIS	environmental impact statement
EMT	emergency medical technician
EO	Executive Order
ESA	Endangered Species Act of 1973
FCR	Fire Cracked Rock
FEIS	Final Environmental Impact Statement
FLAG	Federal Land Managers' Air Quality Related Values Workgroup
FLPMA	Federal Land Policy and Management Act of 1976
ft	feet
FY	fiscal year
gal	gallons
GDR	Great Divide Resource Area
GIS	geographic information system
GLEES	Glacier Lakes Ecosystem Experiment Site
gpd	gallons per day
gpd/ft	gallons per day per foot
gpd/ft ²	gallons per day per square foot
gpm	gallons per minute
GPS	Global Positioning System
HABS	Historic American Buildings Survey
HAER	Historic American Engineering Record
HAP	Hazardous Air Pollutants
HMA	herd management area
HSI	Hydro-Search, Inc.
HUC	hydrologic unit code
HWA	Hayden-Wing Associates

LIST OF ACRONYMS/ABBREVIATIONS

I-80	Interstate 80
IDP	interim exploration drilling program
IDT	interdisciplinary team
IMPLAN	impact analysis for planning
IMPROVE	Interagency Monitoring of PROtected Visual Environments
JTU	Jackson turbidity units
kg/ha-yr	kilograms per hectare per year
km	kilometers
KMDA	known mineral deposit area
LAC	level of acceptable change
lb	pound(s)
LMWL	Local meteoric water line
LOC	levels of concern
LOP	life-of-project
LOS	level of service
LSRCD	Little Snake River Conservation District
LSRV	Little Snake River Valley
MA	Management Area
MCF	thousand cubic feet
meq/L	milliequivalents per liter
MEI	maximally-exposed-individual
mg/L	milligrams per liter
mi ²	Square mile
mL	micro liter
MLE	most-likely-exposure
MMCF	million cubic feet
mmcf/d	million cubic feet per day
MOA	Memorandum of Agreement
MODFLOW	Three Dimensional Finite Difference Modular Groundwater Flow Model
MOU	Memorandum of Understanding
mph	miles per hour
MSDS	Material Safety Data Sheet
MSUP	Master Service Use Plan

LIST OF ACRONYMS/ABBREVIATIONS

N	nitrogen
n/a	not applicable
NAAQS	National Ambient Air Quality Standards
NADP	National Acid Deposition Program
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NARCS	National Applied Resource Sciences Center
ND	non-detect
NEIC	National Earthquake Information Center
NEP	National Energy Policy
NEPA	National Environmental Policy Act
NGPC	Nebraska Game and Parks Commission
NHPA	National Historic Preservation Act
NM	not measured
NOA	Notice of Availability
NO ₂	nitrogen dioxide
NO _x	nitrogen oxides
NPC	National Petroleum Council
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	National Resources Conservation Service
NRDC	Natural Resources Defense Council
NRHP	National Register of Historic Places
NSR	New Source Review
NTN	National Trends Network
NTU	normal turbidity unit
NWI	National Wetland Inventory
O ₃	ozone
OHV	off-highway vehicles
OSHA	Occupational Safety and Health Administration
OUT	non-use areas
P & A	plugged & abandoned
PA	Programmatic Agreement
PAH	polynuclear aromatic hydrocarbons
PCA	Portland Cement Association
pCi/L	picocuries per liter
PEDCO	Petroleum Development Corporation
PFC	Proper Functioning Condition

LIST OF ACRONYMS/ABBREVIATIONS

pH	measure of acidity or alkalinity
PLS	pure live seed
PM ₁₀	particulate matter less than 10 microns
PM _{2.5}	particulate matter less than 2.5 microns
POD	plan of development
POM	polycyclic organic matter
PRBP	Powder River Basin Oil & Gas Development Project
PSD	Prevention of Significant Deterioration
psi	pound per square inch
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration for chronic inhalation
RFD	reasonably foreseeable development
RFFA	reasonably foreseeable future activities
RFO	Rawlins Field Office
REL	reference exposure limit
RIP	Recovery Implementation Plant
RMG	Reservoir Management Group
RMP	Resource Management Plan
RMPPA	Resource Management Plan Planning Area
ROD	Record of Decision
ROW	right-of-way
RPM	Reactive Plume Model
RV	recreational vehicle
S	sulfur
SAR	sodium absorption ratio
SARA	Superfund Amendments and Reauthorization
scf	standard cubic feet
SCCA	South Central Conservation Area
SCS	Soil Conservation Service
SEO	State Engineer's Office
SHPO	State Historic Preservation Office
SMA	Special Management Area
SMOW	an international standard used for oxygen and hydrogen isotopic analysis
SO ₂	sulfur dioxide
SO ₄	sulfate
SPCC	Spill Prevention Control and Countermeasures
sq.mi.	square mile

LIST OF ACRONYMS/ABBREVIATIONS

SSF	spring/summer/fall
s.u.	standard units
SUP	Surface Use Plan
SVR	standard visual range
SWPPP	Storm Water Pollution Prevention Plan
SWR	severe winter relief areas
TCF	trillion cubic feet
TCP	traditional cultural properties
TDS	total dissolved solids
TEC&SC	threatened, endangered, candidate, and other species of concern
TSS	total suspended solids
TU	Tritium Unit
UGBMA	Upland Game Bird Management Area
UGMA	Upland Game Management Area
UND	undefined areas
UNK	unknown
USDA	United States Department of Agriculture
USDA-FS	United States Department of Agriculture Forest Service
USDA-SCS	United States Department of Agriculture, Soil Conservation Office
USDI	United States Department of the Interior
USDI-BLM	United States Department of the Interior, Bureau of Land Management
USDI-FWS	United States Department of the Interior, Fish and Wildlife Service
USDL-BLS	United States Department of Labor, Bureau of Labor Statistics
USDOT	United States Department of Transportation
EPA	United States Environmental Protection Agency
USFWS	United States Fish & Wildlife Service
USGS	United State Geological Survey
UW	University of Wyoming
VOC	volatile organic compounds
VRM	Visual Resource Management
WAAQS	Wyoming Ambient Air Quality Standards
WAS	Western Archaeological Services
WDAI	Wyoming Department of Administration and Information
WDE	Wyoming Department of Employment
WDEA	Wyoming Division of Economic Analysis
WDEQ	Wyoming Department of Environmental Quality
WDEQ-AQD	Wyoming Department of Environmental Quality – Air Quality Division

LIST OF ACRONYMS/ABBREVIATIONS

WDEQ-WQD	Wyoming Department of Environmental Quality – Water Quality Division
WDOR	Wyoming Department of Revenue
WGFD	Wyoming Game and Fish Department
WGS	Wyoming Geological Survey
WHDP	Wyoming Housing Database Partnership
WHMA	Wildlife Habitat Management Area
WIN	winter
WOGCC	Wyoming Oil and Gas Conservation Commission
WOS	Wildlife Observation System
WRCC	Western Regional Climate Center
WRDS	Water Resource Data Center
WRES	Warren Resources Incorporated
WRS	Wyoming Revised Statutes
WS	Wyoming Statutes
WSLUC	Wyoming State Land Use Commission
WTA	Wyoming Taxpayers Association
WWC	WWC Engineering
WY	Wyoming State Highway
WYDOT	Wyoming Department of Transportation
WYL	winter/yearlong
WYNDD	Wyoming Natural Diversity Database
WYPDES	Wyoming Pollutant Discharge Elimination System
yr	year

Chapter 1

Purpose and Need

1 Purpose and Need

1.1 Introduction

This environmental impact statement (EIS) was developed to evaluate the impacts from the Atlantic Rim Natural Gas Project, which is located in Carbon County, Wyoming (appendix M, map M-1). For this project, Anadarko E & P Company, LP (AEPC) and other operators propose developing coal bed natural gas (CBNG) and conventional gas wells on federal land administered by the Bureau of Land Management's (BLM's) Rawlins Field Office (RFO).

Because the operators have not yet identified specific well locations with effective natural gas production, the BLM is unable to evaluate impacts at specific well sites. However, the interdisciplinary team (IDT) can evaluate impacts on a broad, project-wide level. While this field development EIS evaluates the broad project area, specific impacts will be evaluated annually based on site-specific proposals.

The State of Wyoming is a cooperating agency in this EIS with active participation from many agencies including in part the State Planning Office, Wyoming Game and Fish Department, the State Historic Preservation Office, the Wyoming Department of Environmental Quality, and the Wyoming Department of Agriculture. Other cooperating agencies include the Saratoga Encampment Rawlins Conservation District and the Little Snake River Conservation District.

Maps, tables and figures are interspersed throughout the document; consult the table of contents for specific page numbers. Appendices are included behind the text. All maps are included in appendix M. References cited in the document are detailed in the "References Cited" section following chapter 6 in the Final EIS. Definitions of terms can be found in the "Glossary" section located behind the "References" section of the Final EIS.

1.2 History of Development

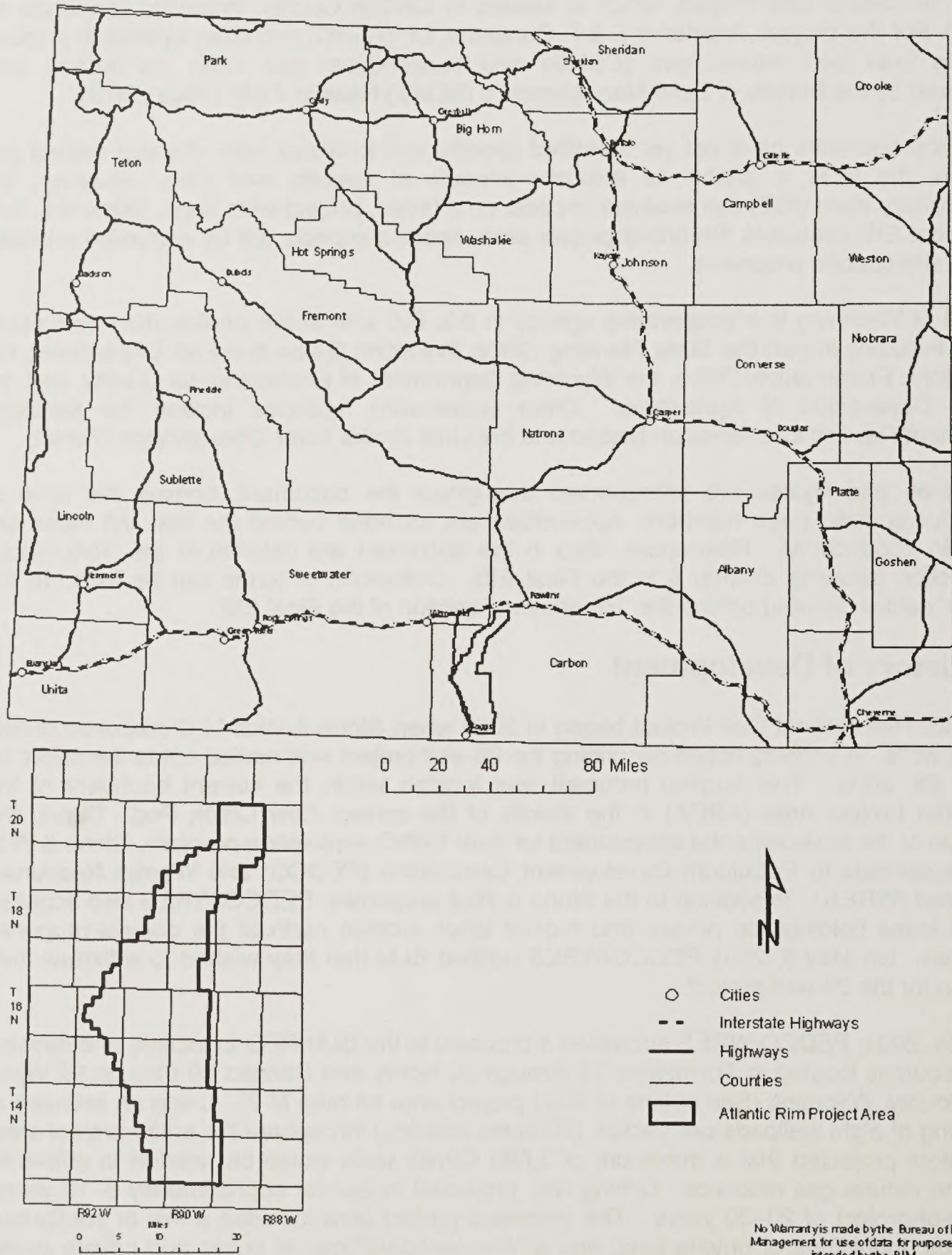
The Atlantic Rim Natural Gas Project began in 2000 when Stone & Wolf LLC proposed drilling 96 CBNG wells. A scoping notice describing the 96-well project was mailed out to the public on February 25, 2000. This original proposal was located within the current boundary of the Atlantic Rim Project Area (ARPA) in the vicinity of the current Cow Creek Pod. During the preparation of the environmental assessment for their CBNG exploration program, Stone & Wolf sold its leaseholds to Petroleum Development Corporation (PEDCO) and Warren Resources Incorporated (WRES). In addition to the Stone & Wolf properties, PEDCO/WRES also acquired additional lease holdings on private and federal lands located north of the original proposed project area. On May 3, 2001 PEDCO/WRES notified BLM that they wished to withdraw their application for the 96-well project.

On May 24, 2001, PEDCO/WRES submitted a proposal to the BLM RFO to explore and develop CBNG resources located in Townships 13 through 20 North, and Ranges 89 through 92 West, Carbon County, Wyoming (See outline of 2001 project area on map M-2). Using an estimate of well-spacing of eight wellpads per section (80-acres spacing) throughout the entire project area, the operators projected that a maximum of 3,880 CBNG wells would be needed to efficiently recover the natural gas resource. Drilling was projected to last for approximately 6–10 years, with a life-of-project of 20–30 years. The proposed project area included a mix of contiguous public lands, inholdings of private land, and a "checkerboard" mix of public and private lands. After reviewing the new proposal, the BLM determined that the increase in CBNG well numbers

CHAPTER 1. PURPOSE AND NEED

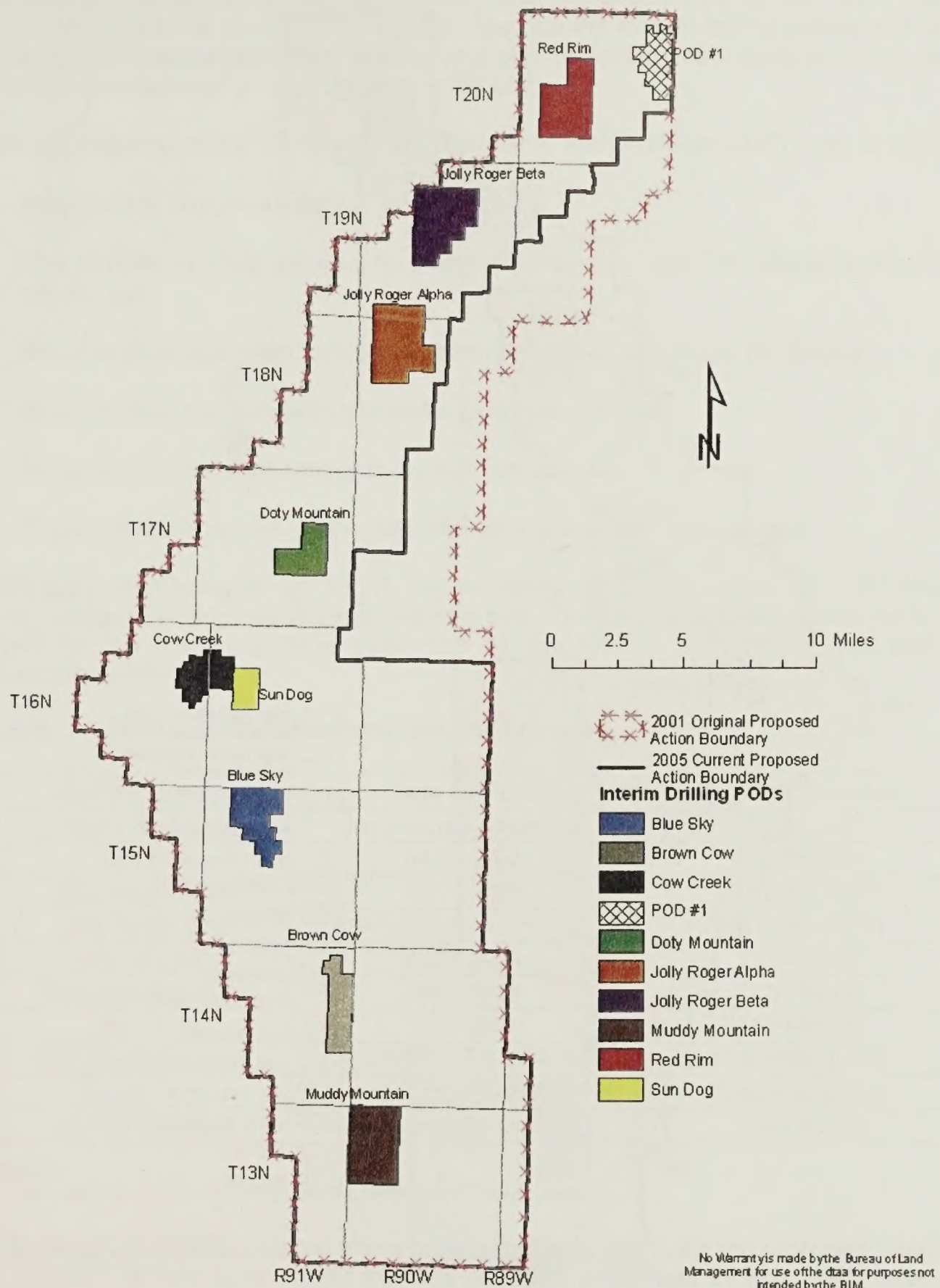
and the level of development activity could potentially result in significant impacts and that an EIS would be necessary. The scoping period for the Atlantic Rim CBNG project commenced on June 26, 2001 with publication of the Notice of Intent in the Federal Register.

Map M-1. Project Area Map.



CHAPTER 1. PURPOSE AND NEED

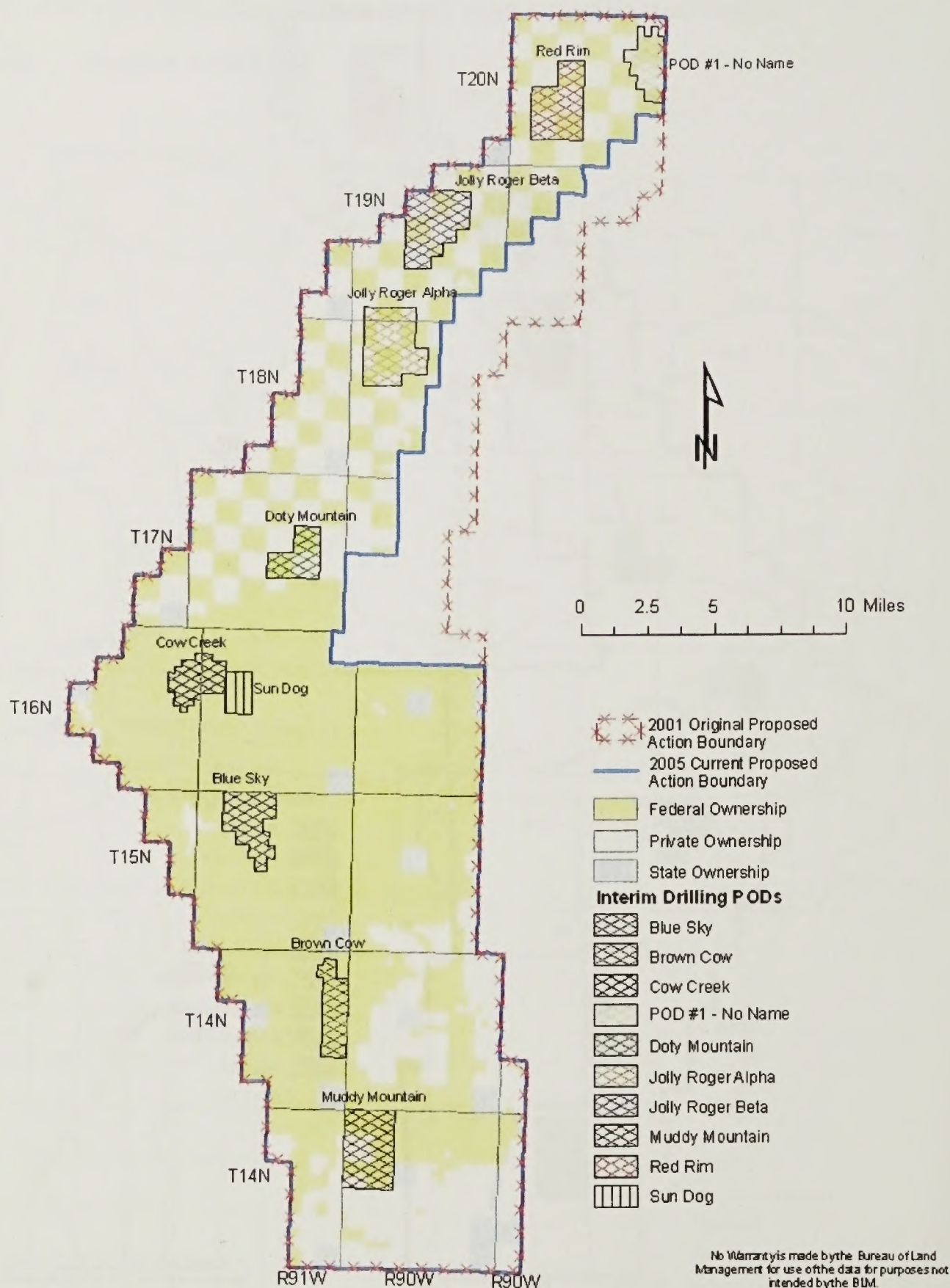
Map M-2. 2001 Project Area.



As described in the Notice of Intent the project area encompassed approximately 310,000 acres and is comprised of a mix of federal, State of Wyoming and private land ownership (See map M-3 Ownership).

CHAPTER 1. PURPOSE AND NEED

Map M-3. Ownership.



In January 2002, the BLM RFO in conjunction with the BLM's Reservoir Management Group (RMG) developed an interim drilling policy for the Atlantic Rim area (appendix A). This would allow the operators to conduct exploratory drilling in a systematic manner for the purpose of

CHAPTER 1. PURPOSE AND NEED

obtaining additional information that would be used to support the geologic information needed for the EIS. The RFO agreed with WRES that exploratory drilling could proceed following site-specific environmental review, concurrently with the preparation of the EIS. The interim exploration drilling program (IDP) was used to describe the interim drilling criteria and allowed a maximum of 200 exploration CBNG wells in nine plan of development (pod) locations; each pod may include development of up to 24 wells (map M-2).

The primary objective of the IDP was to drill, complete, and produce CBNG wells to determine:

- Gas content and productivity of the coals,
- The density of wells needed to effectively dewater coal formations and produce natural gas,
- Whether produced water can be effectively disposed of through re-injection,
- Which drilling and completion techniques are economical,
- Water quality and connectivity to surface waters, and
- The formation size and depths that offer economical gas production.

Environmental assessments for six of the proposed pods (as shown on map M-2) were prepared, decision records issued and implemented. To date the operators have not submitted proposals for the remaining three pods: Pod #1 (No Name), Jolly Roger Beta and Muddy Mountain (See table 1-1).

Table 1-1. Current POD Status and General Location.

EA/Pod Name	Date of ROD	General Location
Pod#1 No Name	No proposal submitted	T20N-R89W
Red Rim	04-30-2004	T20N-R89W
Jolly Roger Alpha	12-14-2004	T18 &19N-R90W
Jolly Roger Beta	No proposal submitted	T18 &19N-R90W
Doty Mountain	02-06-2004	T17N-R91W
Doty Mountain Fee ¹	06/17/2006	T17N-R91W
Blue Sky	7-26-2002	T15N-R91W
Sun Dog/Cow Creek	12/21/2001 & 6-26-2002	T16N-R90 & 91W
Brown Cow	12-12-03 Phase I	T14N-R90 & 91W
Muddy Mountain	No proposal submitted	T14N-R90W

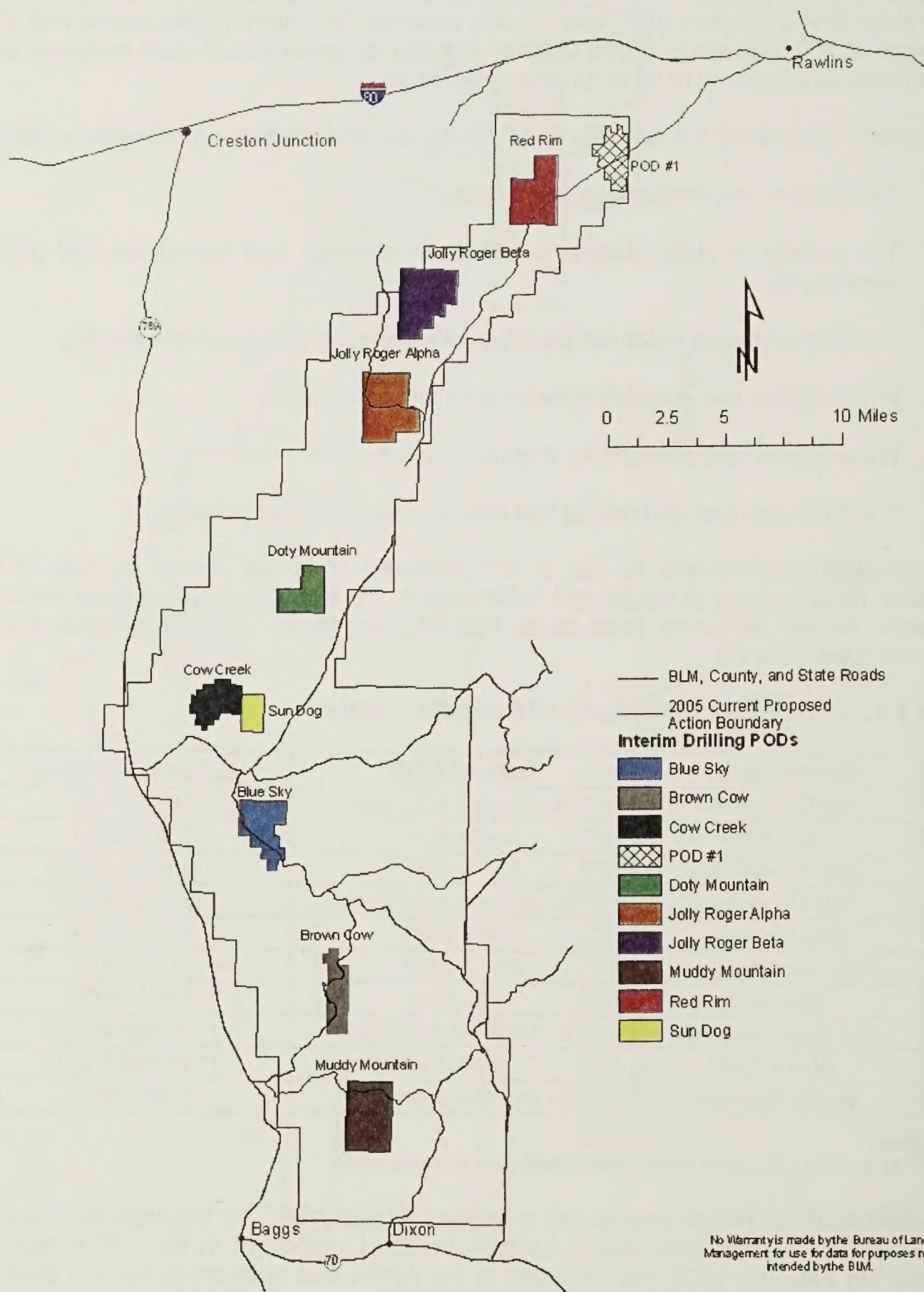
Note:

¹ This activity is outside of the BLM's jurisdiction of development.

In December 2002, WRES entered into a partnership with AEPC for the proposed development of the ARPA. At that time, AEPC became the lead proponent in the ARPA development process. In February 2005, the boundary of the ARPA was redrawn to the one illustrated on map M-4, reducing the size of the project area by approximately 40,000 acres. In the spring of 2006, the BLM approved right-of-way access across public land so that the AEPC could access their private land and develop private minerals. This pod is known as Doty Mountain Fee on private land. In September 2006 the BLM approved the Brown Cow II Pod, submitted by AEPC.

CHAPTER 1. PURPOSE AND NEED

Map M-4. 2005 Proposed Action Project Area.



CHAPTER 1. PURPOSE AND NEED

1.2.1 Project Location and Ownership

The Atlantic Rim area is located within the administrative boundary of the BLM RFO. The proposed ARPA is generally located in Townships 13 through 20 North, and Ranges 89 through 92 West, Carbon County, Wyoming. The total project area encompasses approximately 270,080 acres, of which 173,672 acres are federal surface; 14,060 acres are State of Wyoming lands; and 82,348 acres are private surface (table 1-2 and map M-3).

Table 1-2. Surface Ownership within the Atlantic Rim Project Area.

Area	Acres	% of Project Area
Federal	173,672	64
State	14,060	5
Fee	82,348	31
Total	270,080	100

Surface ownership does not always correspond to mineral ownership. As detailed in tables 1-2 and 1-3, the BLM-RFO manages more mineral estate than surface estate within the ARPA. Within the ARPA about 5 percent of the surface are owned by the State of Wyoming and associated mineral estate. The BLM does not control or authorize mineral development on private or state lands except for areas where BLM controls the mineral rights. Approximately 2 percent of the ARPA is a combination of private land surface with underlying federal mineral estate. In addition to administering the federal lands with underlying federal minerals the BLM has the authority to manage the federal mineral estate when the surface may be held in private ownership. Because proposals to remove federal minerals are considered actions subject to federal approval, the BLM must comply with National Environmental Policy Act (NEPA) before authorizing such actions. In cases where development is proposed on private or state lands, but access through BLM-managed lands is necessary, BLM will conduct the appropriate level of NEPA analysis, including cumulative impacts resulting from the private actions, prior to authorizing the right-of-way.

Table 1-3. Mineral Ownership within the Atlantic Rim Project Area.

Area	Acres	% of Project Area
Federal	179,438	66
State	12,384	5
Private	78,258	29
Total	270,080	100

1.2.2 Project Description

AEPC of Houston, Texas, has submitted a proposal to the BLM RFO that they and other operators^a (including Double Eagle Petroleum and Mining Company and WRES) propose exploring and developing CBNG resources located within the administrative boundary of the BLM RFO. Approximately 1,800 wells would produce CBNG from coal formations in the Mesaverde group, and 200 wells would produce natural gas from deeper formations. Because of the geologic formations and what is known about their strata the operators assume one well / bore hole for each pad. The Wyoming Oil and Gas Conservation Commission (WOGCC) has

^a AEPC and the other operators are referred to as *operators* through the remainder of this EIS.

CHAPTER 1. PURPOSE AND NEED

approved producing well spacing density for the Mesaverde Group of 8 wells per 640 acres (township section). The operators estimate this spacing should be adequate for the most economic recovery of the gas resource. Drilling is expected to occur over approximately 20 years, with an estimated life-of-project of 30–50 years.

As summarized in section 1.2.1, interim exploration drilling has taken place within the ARPA with BLM approval. Table 1-4 describes IDP Pods and well status.

Table 1-4. Status of Well Development within PODs.

POD#	Name	Acres	Wells Approved				Project Status
			Gas	Injection	Monitor	Total	
1	Not Planned	-x-x-	0				Dropped by Proponent
2	Red Rim	Pending	16	2		18	Approved 4/30/04
4	Jolly Roger Alpha	5,120	26	2	1	29 ¹	Approved 12/14/04
3	Jolly Roger Beta	-x-x-	0				Not Proposed to Date
5	Doty Mountain ²	1,920	24	2		26	Completed
7	Blue Sky	1,921	23	2	1	25	In-fill Drilling in Progress
6	Sun Dog	1,000	10	1		11	Completed
6	Cow Creek	2,050	14	1	1	16	Completed
8	Brown Cow	800	24	2		26	Completion Expected Fall 2006
9	Muddy Mtn.						On Hold—Environmental Concerns

Notes:

¹ Number may decrease.

² Doty Mountain Fee not included, BLM approval was for right-of-way access only.

1.3 Purpose of and Need for Action

Exploration and development of federal oil and gas leases by private industry are an integral part of the BLM's oil and gas leasing program under authority of the Mineral Leasing Act of 1920 as amended, the Mining and Minerals Policy Act of 1970, the Federal Land Policy and Management Act of 1976 (FLPMA), the National Materials and Minerals Policy, Research and Development Act of 1980, and the Federal Onshore Oil and Gas Leasing Reform Act of 1987. Under its authority to issue oil and gas leases and consistent with the RMP, the RFO has leased federal minerals within the entire ARPA.

The BLM oil and gas leasing program encourages development of domestic oil and gas reserves. Natural gas (including CBNG) is an integral part of the United States' energy future due to its availability and the presence of the existing market delivery infrastructure. By developing domestic reserves of clean-burning natural gas, the U.S. would reduce dependence on foreign energy, such as natural gas from Mexico and Canada. The environmental advantages of burning natural gas, rather than oil or coal, were emphasized by the U.S. Congress and by the President when the Clean Air Act Amendments of 1990 were signed into law. In addition, the Energy Policy acts of 2001 and 2005 emphasize the development of domestic natural gas reserves for supply and economic stability.

CHAPTER 1. PURPOSE AND NEED

To meet the growing demand for energy, the National Petroleum Council projects that U.S. domestic gas production will increase from the 2002 level of 18 trillion cubic feet (TCF) to 21 TCF in 2025. Any shortfall in domestic supply will be met by imports of foreign natural gas, primarily from Canada. A portion of the increase in domestic supply is projected to be met by growth in production from nonconventional sources, including CBNG, from the Rocky Mountain region. Nonconventional production in the Rocky Mountain region (including Wyoming) is projected to increase to 3.8 TCF in 2020 from the 2000 level of 3.1 TCF (EIA 2001). In addition, the Report of the National Energy Policy Development Group states that 90 percent of electric power generation capacity additions between 1999 and 2020 are projected to be natural-gas-fueled. The quantity of natural gas consumed for power generation is expected to triple from 1999 to 2020 (NEP 2001). Production from the proposed Atlantic Rim Natural Gas Project could help meet this demand.

The purpose of, and need for, this proposed natural gas development is to develop, produce, and market natural gas products. This natural gas is needed to meet the national domestic energy demand. This proposal is consistent with the National Energy Act of 2005 and the National Energy Policy (President's Plan).

1.4 Relationship to Policies, Plans, and Programs

When analyzing environmental impacts, other policies, plans, and programs were considered. For this EIS, the Great Divide Resource Management Plan (RMP) and other EISs within the immediate vicinity of the ARPA were considered, as explained below.

1.4.1 Conformance with the Great Divide Resource Area Management Plan EIS and Record of Decision

The BLM's Great Divide RMP and its Record of Decision (ROD) (USDI-BLM 1990) directs management of the federal lands within the project area. The Great Divide RMP reviewed all public lands in the resource area and deemed them suitable for oil and gas leasing and development, subject to certain stipulations. The proposed project is in conformance with management objectives and actions provided for in the ROD, and as detailed on pages 30–32 of the Record of Decision and Approved Resource Management Plan for the Great Divide Resource Area. The Great Divide RMP is currently undergoing revision as the Rawlins RMP.

1.4.1.1 Management Objectives

Management objectives identified in the Great Divide RMP that are applicable to the Proposed Action and alternatives include the following:

- To provide opportunity for leasing, exploration, and development of oil and gas while protecting other resource values.

1.4.1.2 Management Actions

Management actions identified in the Great Divide RMP that are applicable to the proposed action and alternatives include:

- The entire planning area is open to oil and gas leasing, subject to stipulations needed to protect resources. This action is in conformance with the Great Divide RMP.

CHAPTER 1. PURPOSE AND NEED

1.4.2 Relationship to Other Plans and Documents

Other environmental analyses and plans completed or planned for completion in the immediate vicinity of the ARPA (map M-5) include the following documents:

Little Snake River Conservation District (LSRCD) Watershed Management Plan. The Proposed Action is located within the LSRCD. The LSRCD is a subdivision of the State of Wyoming that receives its statutory authority from Title 11, Chapter 16 of the Wyoming Statutes (WS). Statutory authorities and responsibilities of conservation districts include the development of comprehensive plans for range improvement and stabilization; soil and water conservation; flood control; and the development of ordinances, rules, and regulations to implement conservation plans. Conservation is defined as "...development, improvement, maintenance, preservation, protection and use of natural resources, and the control and prevention of flood water and sediment damages, and the disposal of excess waters" (WS 11-16-102 [iv]). The District is participating in this EIS process as a cooperating agency.

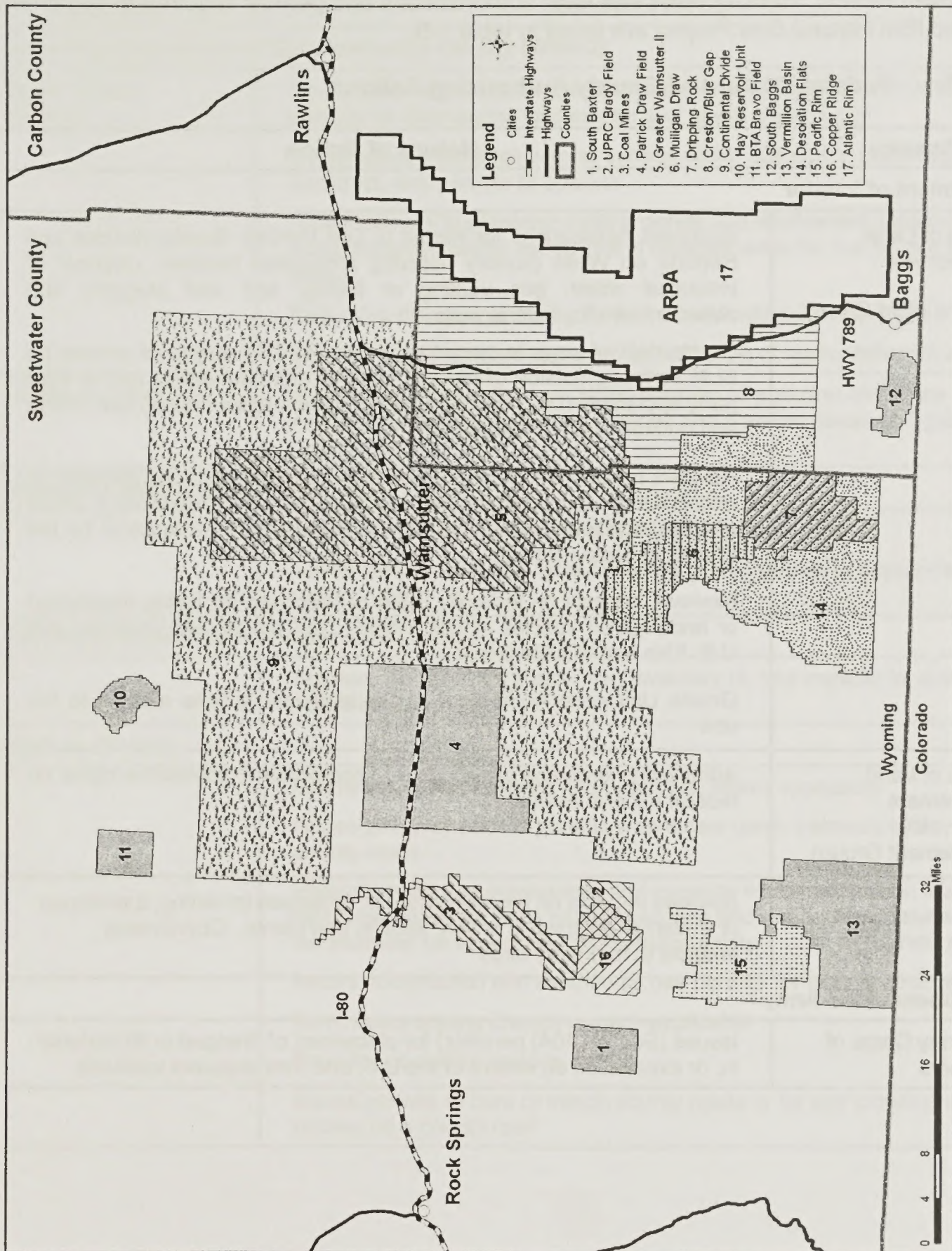
Continental Divide—Creston Natural Gas Field Development Project Environmental Impact Statement. This natural gas development project area is generally located in Townships 14 through 24 North and Ranges 91 through 98 West in Carbon and Sweetwater counties. The total project area includes approximately 1.1 million acres. The proposal includes drilling and developing up to 8,950 wells with 40-acre downhole well spacing per section in limited areas. Associated facilities include additional roads, gas and water collection pipelines, compressor stations, and any electrical/power system development.

This oil and gas development proposal partially overlays earlier field development EIS's that analyzed natural gas development at a less intense level. The Continental Divide / Wamsutter II project approved 2,130 wells and was issued in May, 2000. The combined project area is generally located in Townships 15 through 23 North, Ranges 91 through 99 West, in Sweetwater and Carbon Counties, Wyoming. The total combined area encompasses approximately 1,061,200 acres and is still drilling wells under the original proposal.

The Creston Blue Gap EIS was approved on October 4, 1994, and provided an assessment of the environmental consequences of a natural gas development located immediately west of the Atlantic Rim area. The BLM's decision allowed a maximum of 275 wells on 250 locations on a 160-acre spacing pattern.

CHAPTER 1. PURPOSE AND NEED

Map M-5. Mineral Development Projects in the Vicinity.



CHAPTER 1. PURPOSE AND NEED

1.5 Authorizations and Permits

The proposed federal, state, county, and local authorizations and permits required to implement the Atlantic Rim Natural Gas Project are listed in table 1-5.

Table 1-5. Federal, State, and County Authorizing Actions.

Agency	Nature of Action
Department of Interior	
Bureau of Land Management (Rawlins Field Office)	Approves Applications for Permit to Drill (APDs); Sundry Notices and Reports on Wells (sundry notices); production facilities; disposal of produced water, gas venting or flaring; and well plugging and abandonment for federal wells Grants right-of-ways to operators for gas field development actions on BLM surfaces outside of federal lease or unit boundaries and to third party applicants (i.e., non-unit operator or non-lease holder) both within and outside of the unit boundary Reviews inventories of, and impacts to, cultural resources affected by undertakings and consults with the state Historic Preservation Office and the Advisory Council on Historic Preservation as required by the Wyoming State Protocol Reviews impacts on federally listed or proposed for listing threatened or endangered species of fish, wildlife, and plants, and consults with U.S. Fish and Wildlife Service Grants Unit Area Agreement and subsequent actions relative to the unit
Bureau of Land Management (Reservoir Management Group)	Administers drainage protection and protection of correlative rights on federal mineral estate
U.S. Fish and Wildlife Service	Reviews impacts on federally listed or proposed-for-listing, threatened or endangered species of fish, wildlife, and plants. Coordinates impacts to migratory birds
Department of the Army	
U.S. Army Corps of Engineers	Issues (Section 404) permit(s) for placement of dredged or fill material in, or excavation of, waters of the U.S. and their adjacent wetlands

CHAPTER 1. PURPOSE AND NEED

Table 1-5. Federal, State, and County Authorizing Actions.

Agency	Nature of Action
Wyoming Department of Environmental Quality (WDEQ)	
Water Quality Division	Issues Wyoming Pollution Discharge Elimination System (WYPDES) permits for discharging wastewater and storm water runoff Oversees conformance with all surface water standards, permits to construct, and permits to operate Issues permits to construct settling ponds and wastewater systems including groundwater injection and disposal wells for non oil and gas uses. Regulates disposal of drilling fluids from abandoned reserve pits Provides administrative approval for discharge of hydrostatic test water
Air Quality Division	Issues New Source Review (NSR) permits: all pollution emissions sources including compressor engines and portable diesel and gas generators
Wyoming State Engineer's Office	
	Issues permits to appropriate ground and surface water Issues temporary water rights for construction permits to appropriate surface water
Wyoming State Historic Preservation Office	
	Provides consultation concerning inventory of, and impacts to, cultural resources
Carbon County	
	Grants small wastewater system permits, where applicable Issues driveway access permits where new roads intersect with county roads Prepares road use agreements and oversize trip permits when traffic on county roads exceeds established size and weight limits or where the potential for excessive road damage exists Issues construction and conditional use permits for all new structures Administers zoning changes where applicable Provides control of noxious weeds Issues permits to bore or trench county roads or for any crossing or access off a county road

CHAPTER 1. PURPOSE AND NEED

Table 1-5. Federal, State, and County Authorizing Actions.

Agency	Nature of Action
Wyoming Oil and Gas Commission	
	Acts as primary authority for drilling on state and privately held mineral resources, and secondary authority for drilling on federal lands
	Holds authority to allow or prohibit flaring or venting of gas on privately or state-owned minerals
	Regulates drilling and plugging of wells on privately or state-owned minerals
	Issues Aquifer Exemption Permits
	Approves directional drilling
	Administers rules and regulations governing drilling units
	Issues water injection well permits
	Grants gas injection well permits
	Administers drainage protection and protection of correlative rights on private/state mineral estates

1.6 Public Participation

Scoping for the Atlantic Rim Natural Gas project was initiated on June 26, 2001. The State of Wyoming; federal agencies; state and local government representatives; municipalities; Native American Tribes; grazing permittees; lease and right-of-way holders; landowners within the ARPA; local media; and other agencies, industry representatives, individuals, and organizations were sent a scoping notice and other information by mail. Two public meetings were held during scoping at Baggs and Rawlins Wyoming. Fifty-seven comments were received in the form of letters, emails, and faxes from the public including citizens; interested federal, state, and local agencies; advocacy groups; and various corporations. These comments were used to determine key issues, resource conflicts and concerns, alternatives, and the scope of the analysis. Key issues and concerns are listed in table 1-6 in section 1.7. Interested agencies were invited to participate as cooperating agencies. The State of Wyoming, Little Snake Conservation District, and Carbon County Commissioners requested and received Cooperating Agency status.

The Draft Atlantic Rim EIS was released in December 2005. The 60-day comment period resulted in over 59,400 individual comments including approximately 59,100 emails and 300 hardcopy comments. Comments were received from state, federal, and local agencies; environmental advocacy groups; landowners; leaseholders; oil and gas companies; and the public. Comments received were reviewed and substantive comments responded to. Those letters and emails with substantive comments are provided as appendix N, with comment responses provided as appendix O.

Comments were used to develop Alternative D and to modify, clarify, and correct the Final EIS, as appropriate.

CHAPTER 1. PURPOSE AND NEED

1.7 Issues and Concerns

During the scoping period for the Atlantic Rim Natural Gas Project, thirteen issues and concerns were brought up by the stakeholders referenced in section 1.6. These issues and concerns are summarized below in table 1-6, along with a reference to the section in this EIS where they are addressed. Comments to the Draft EIS developed two additional key issues, directional drilling / well spacing and phased development.

Table 1-6. Key Issues and Concerns Identified during the Scoping Period

Issue	Description of Issue	Where Is Issue Addressed?
1. Increased traffic	Increased traffic on existing county, state, and BLM roads can result in: ▪ Increased traffic hazards, ▪ Higher maintenance costs, ▪ The need to upgrade roads, and ▪ More intensive transportation planning.	Section 4.13
2. Adverse socioeconomic impacts to local communities	Impacts to local communities include: ▪ Demand for housing that might exceed local capabilities, ▪ Demand for local services—such as medical, retail, and civic—beyond the capacity of the community to deliver, and ▪ The need to expand local government services and presence without corresponding revenue/compensation from increased development.	Section 4.12

CHAPTER 1. PURPOSE AND NEED

Table 1-6. Key Issues and Concerns Identified during the Scoping Period

Issue	Description of Issue	Where Is Issue Addressed?
3. Impacts to surface water hydrology and groundwater resources.	The following could impact surface water: ▪ Production of large amounts of water from coal formations with corresponding discharges into the Colorado River system would affect water quality and local and non-local government agreements. ▪ The project might also cause changes in water quality and the presence of sensitive fish species within Muddy Creek. ▪ Continuous surface water discharges into ephemeral and intermittent stream courses could increase erosion. The following could impact surface hydrology: ▪ Increased road density could cause higher overland flows. ▪ Higher overland flows could increase erosion and correspondingly increase salt and sediment delivery within the Colorado River system. ▪ Increased erosion from higher overland flows could adversely impact water quality. Impacts to groundwater resources include: ▪ Sedimentation/excess salts to the Colorado River system, ▪ Potential changes in groundwater aquifers due to the reduction of hydrostatic pressure in the coal seams and re-injection, ▪ Decrease or elimination of water, which can have a serious adverse effect on habitats and dependent populations of plants and wildlife who use the local wells, springs, and seeps.	Sections 4.4 and 4.8, and Alternatives C and D
4. Impacts to sensitive soils	Impacts to sensitive soils would need to be mitigated by maintaining and preserving sensitive soils that have: ▪ Difficult reclamation potential, ▪ High runoff potential, and ▪ Excess salt.	Sections 4.3 and 4.5 and Alternatives C and D

CHAPTER 1. PURPOSE AND NEED

Table 1-6. Key Issues and Concerns Identified during the Scoping Period

Issue	Description of Issue	Where Is Issue Addressed?
5. Impacts to air quality	Drill rig emissions and production activities could cause the following impacts to air quality: ▪ Regional haze and ▪ Increased dust and emissions levels, particularly within Class I airsheds associated with nearby wilderness areas.	Sections 4.2 and 4.4
6. Viability of reclamation	The following reclamation should be ensured: ▪ Successful and timely reclamation, ▪ Control of noxious weed invasions, ▪ Immediate soil stabilization, ▪ Interim reclamation within the first growing season, and ▪ Monitoring of reclamation success with adaptive management in difficult areas.	Sections 4.4 & 4.5 Appendix B BMP H-4 in appendix H Alternatives C and D
7. Potential conflicts with livestock management operations	Potential conflicts with livestock management operations could include: ▪ Reduced forage availability, ▪ Increased livestock disturbance and harassment, ▪ Reduced viability of range improvement projects, and ▪ Compromised range/vegetation quality.	Sections 4.3, 4.5, and 4.6, and Alternatives C and D
8. Impacts to cultural resources	Impacts to cultural resources and resulting risks to significance criteria established by the National Historic Preservation Act could include: ▪ Historic trails and ▪ Sites eligible for inclusion in the National Register of Historic Places.	Section 4.11 and Alternative C

CHAPTER 1. PURPOSE AND NEED

Table 1-6. Key Issues and Concerns Identified during the Scoping Period

Issue	Description of Issue	Where Is Issue Addressed?
9. Impacts to wildlife habitats	To mitigate impacts to wildlife habitats—including those supporting big game, greater sage-grouse, and raptors—the following needs were identified: ▪ Protecting and maintaining crucial winter range for big game, critical winter habitat, and nesting/brood-rearing habitats for sage-grouse; ▪ Maintaining the viability of leks for sage-grouse; ▪ Maintaining raptor populations using timing and disturbance restrictions; ▪ Collecting further information on big game migration corridors; and ▪ Maintaining migration corridors as viable routes for big game.	Section 4.7 and Alternatives C and D
10. Potential impacts to listed or proposed-for-listing threatened and endangered plant and animal species	Impacts to these species include: ▪ Potential depletions to the Colorado River; ▪ Effects on downstream listed, threatened, and endangered species; ▪ Critical habitats, which must be maintained; and ▪ Compliance with Endangered Species Act.	Section 4.8 and Alternatives C and D
11. Potential impacts to sensitive plant and wildlife species	To mitigate impacts to sensitive species—including bluehead sucker, roundtail chub, and flannelmouth sucker—the following needs were identified: ▪ Supporting habitat for sensitive fish species within Muddy Creek and ▪ Preserving or improving supporting habitats including water flows and quality.	Section 4.8 and Alternatives C and D
12. Cumulative effects of project when combined with neighboring projects	Cumulative impacts from drilling and development activities were identified as a concern when combined with other ongoing and proposed developments on lands adjacent to the Atlantic Rim Project Area including: ▪ The area covered by the RFO, ▪ The Red Desert, and ▪ The Greater Green River Basin.	Section 5.2 and Alternatives C and D

CHAPTER 1. PURPOSE AND NEED

Table 1-6. Key Issues and Concerns Identified during the Scoping Period

Issue	Description of Issue	Where Is Issue Addressed?
13. Potential conflicts between mineral development and recreation	The following potential conflicts between mineral development and recreation were identified: ▪ Presence of local, regional, and nationally important big game populations; ▪ Traditional use of land for recreational hunting and wildlife viewing; ▪ Visual resources; and ▪ Risk of decreased recreational opportunities due to the impacts of big game and wildlife populations.	Sections 4.7, 4.9, 4.10, and 4.12 and Alternative C
14. Well spacing and directional drilling (developed from comments to the Draft EIS)	The following conflicts were identified for well spacing and directional drilling: Directional drilling would reduce the surface impact of the proposed action by reducing the number of well pads but allowing for maximum recovery of the gas resource. Directional drilling is not feasible within the project area due to the geology and shallow depth of the target coals ; Wellpad spacing must be 80 acres / wellpad to allow for maximum economic recovery of the resource; 160 acre / wellpad spacing is not close enough to release the natural gas; More than four wellpads / section in portions of the ARPA exceeds the recommendations of the Wyoming Game and Fish Department for oil and gas development.	Alternative D
15. Phased development (developed from comments to the Draft EIS)	The following conflicts were identified for phased development: Phased development as presented in the Draft EIS as Alternative B conflicts with the BLM's policy of allowing reasonable access to private lands across federal lands; Phased development would unreasonably restrict the right of leaseholders by preventing development of some leases for periods ranging from 7 to 14 years.	Alternative B is moved into the section "Alternatives Considered and Eliminated From Detailed Study."

1.8 Issues that Drive Alternative Development

The BLM identified a range of alternatives based on issues, concerns, and opportunities identified from public comments to project scoping and the Draft EIS, interdisciplinary interaction between resource professionals, and collaboration with cooperating and interested agencies. These issues are detailed in section 1.7 “Issues and Concerns”.

Alternative B was responsive to Issue 9, impacts to wildlife habitat and Issue 13, conflicts between mineral development and recreational activities. This alternative proposed that natural gas development activities would be restricted to one of three zones within the ARPA boundary at any one time. Each zone would be open to construction and development of natural gas processing facilities for 7 years at which time construction and development activities would cease. Gas extraction and processing would continue, while construction and development activities would move to another zone. The intent of the alternative was to focus disturbance activities into a smaller area while the remainder of the project area would be less disturbed and less impacted at any one time than under the Proposed Action. Alternative B was analyzed in the Draft EIS and subsequently moved to “Alternatives Considered and Eliminated from Detailed Study”, section 2.3.

Alternative C was developed to be responsive to Issue 3, impacts to surface water hydrology and groundwater resources; Issue 4, impacts to sensitive soils; Issue 6 successful reclamation; Issue 7 conflicts with livestock management; Issue 8, impacts to cultural resources; Issue 9 impacts to wildlife and habitat; Issue 10 impacts to listed or proposed-for-listing threatened and endangered plant and animal species; Issue 11 impacts to sensitive plant and wildlife species; Issue 12 cumulative effects of project when combined with neighboring projects; and Issue 13, potential conflicts between mineral development and recreational opportunities. It proposed to develop natural gas resources while aggressively mitigating impacts to sensitive resource values using additional development protection measures. Comments received to the Draft EIS indicated that due to the stringent nature of the restrictions and the reduced number of surface locations for drilling the alternative was likely not economically feasible nor capable of maximizing the recovery of the natural gas resource.

Alternative D was developed following the Draft EIS and is responsive to Issue 3, impacts to surface water hydrology and groundwater resources; Issue 4, impacts to sensitive soils; Issue 6 successful reclamation; Issue 7 conflicts with livestock management; Issue 9 impacts to wildlife habitat; Issue 10 impacts to listed or proposed-for-listing threatened and endangered plant and animal species; Issue 11 impacts to sensitive plant and wildlife species; Issue 12 cumulative effects of project when combined with neighboring projects; and Issue 14 well spacing and directional drilling. BLM recognized that these impacts can be reduced by limiting the amount of initial disturbance combined with timely reclamation. BLM’s evaluation of IDP development activities determined that average initial and long term disturbance could be reduced by approximately 18% from the Proposed Action (e.g. 60 ft. wide roads vs. 80 ft. width). Alternative D addresses these issues by establishing an unreclaimed surface disturbance cap of 7,600 acres with the goal of averaging 6.5 acres disturbance per well pad within the project area overall and less than 6.5 acres disturbance per well pad in sensitive resource areas.

Chapter 2

Alternatives Including the Proposed Action

2 Alternatives Including the Proposed Action

The BLM identified a range of alternatives based on issues, concerns, and opportunities raised in public comments to project scoping and the Draft EIS, interdisciplinary interaction between resource professionals, and collaboration with cooperating and interested agencies. The alternatives range from no action to the Proposed Action plus intensive reclamation. The Proposed Action and the alternatives are described in this section.

All possible activities associated with each alternative including the no action alternative are assumed to apply to BLM-administered lands only. All activities authorized for the Atlantic Rim Natural Gas Project must comply with the applicable RMP. The applicable RMP at this time is the Great Divide RMP (USDI-BLM 1990). Currently the BLM RFO is revising its RMP and, to date, has issued a Draft EIS in support of the RMP revision. Any future activity that may be authorized based on this EIS must conform to the RMP in effect at the time authorization is requested.

2.1 Introduction

The BLM developed alternatives to the proposed action based on the issues developed during the scoping period and comments to the Draft EIS (chapter 1, parts 1.7 and 1.8), Interdisciplinary team review, input from cooperating agency, and comments to the Draft EIS.

2.2 Alternatives Description

While numerous alternatives and specific actions were considered, four alternatives are studied in detail in this EIS: the Proposed Action, no action (Alternative A), and two additional action alternatives (Alternatives C and D). Alternative B from the Draft EIS has been dropped from further consideration in the Final EIS.

2.2.1 The Proposed Action

The goal for the proposed action is to maximize the economic recovery of gas resources while using best management practices (BMP) and mitigation to reduce effects upon the environment. The operators have submitted a detailed plan of development for the Atlantic Rim project, which is included in this document as appendix K. The following summarizes their proposal:

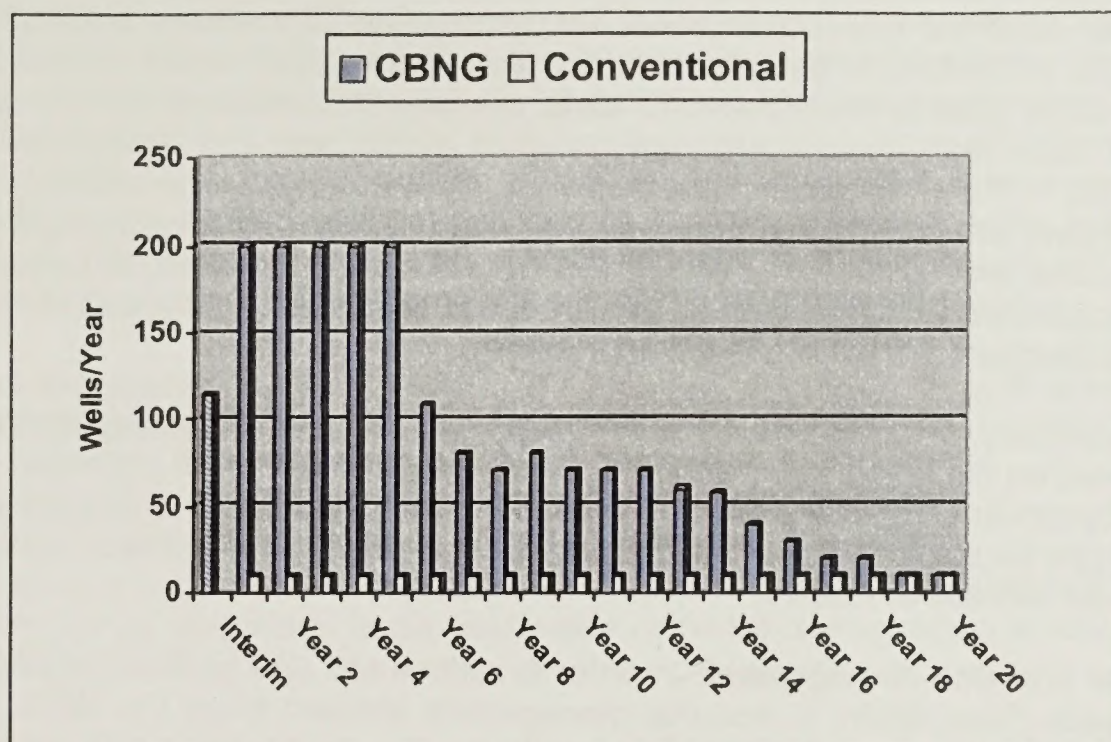
- The Proposed Action consists of drilling and developing approximately 2,000 new natural gas wells. Approximately 1,800 would be drilled to coal formations in the Mesaverde Group to develop CBNG resources. Up to 8 wells on 8 well pads per section (80 acre spacing) would occur. An additional 200 wells would be drilled to access conventional natural gas resources, generally expected to be located deeper than the coal formations in the Mesaverde Group. These wells would be co-located on CBNG pads within CBNG developed areas and spacing would be up to 4 well pads/section.
- The 2,000 proposed, new natural gas wells would be in addition to the approximately 116 existing exploration wells (as of the fall of 2005) developed under the Interim Drilling Policy.

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

- Proposed well spacing for the ARPA is eight wells per section (80-acre spacing). However, this may be reduced to four wells per section (160-acre spacing) depending on the geology and ability of the operators to remove the water and lower the pressure sufficiently to recover gas.
- Development and drilling would begin in 2007 within the ARPA and continue for approximately 20 years, with a life-of-project of 30–50 years. Various drilling and production-related facilities (e.g., roads, pipelines, water wells, disposal wells, compressor stations, and gas processing facilities) would also be constructed throughout the ARPA. The pace of drilling over the life of the project is illustrated on figure 2-1. The majority of the wells expected to be drilled is within the first 6 to 8 years following approval of the project.
- There would be approximately 4,500 acres of new short-term (initial or less than 3 years) surface disturbance from well pads; 1,000 miles (approximately 9,850 acres) of new roads, upgrades of existing roads, and pipeline construction; and 1,480 acres of ancillary facilities. The total new short-term (initial) disturbance resulting from the Proposed Action would be about 15,800 acres or 7.9 acres per well on average.
- Long-term (life-of-project) disturbances following interim reclamation would cover approximately 2,320 acres for wells pads, 3,636 acres for roads and utilities, and 285 acres for ancillary facilities for a total of 6,241 acres (3.1 acres per well on average). Interim reclamation would reduce the total acres of disturbance by about 9,600 acres.
- Produced water from individual wells would be gathered and routed to centralized water handling and storage sites, which would serve as central injection facilities. Produced water would be disposed of through re-injection with two exceptions.
 1. One exception could occur when a proposal comes forward from a land owner or an agency with surface management responsibilities for water for livestock/wildlife watering sites. This could result in the use of closed watering systems for stock and wildlife. These systems will be designed with no discharge of water onto the surface, will have appropriate state permits, and will not be a significant portion of the water disposal needs for the project.
 2. The second exception could occur when landowners or an agency with surface management responsibilities comes forward with a request for water to offset for the loss of current artesian water sources. De-watering of the coal seams has the possibility of drying up artesian water sources as detailed in chapter 4.
- The project proponents have voluntarily committed to a set of mitigation measures as part of the Proposed Action to avoid or reduce impacts from the proposed project. These are presented in appendix K, pages K-20 through K-24.

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Figure 2-1. Proposed Action Annual Drilling Assumptions by Well Type.



Sources: AEPC 2004 and IMPLAN model outputs
Prepared by: Blankenship Consulting LLC (BCLLC)

2.2.2 Alternative A (No Action)

NEPA regulations require that EIS alternative analyses “include the alternative of no action” (40 Code of Federal Regulations [CFR] 1502.14(d)). For this analysis, *no action* means that the BLM would reject the operators’ proposal and the activities would not be approved or authorized. This alternative does not meet the purpose and need of the project which is to promote the development of natural gas resources on federal lands.

Due to the intermingling of federal, state, and private lands within the ARPA, rejection of the operators’ proposal would not mean all oil and gas development in the project area would cease. It is reasonable to assume that subsequent development proposals could be received for access to state and private lands for mineral development, as the BLM does not approve or control development proposals upon these lands. Proposals for access across federal lands for oil and gas development and production-related activities could be received, processed, and approved (as appropriate) by the BLM at any time.

Individual proposals for exploration or development including rights-of-way and access across federal lands would be subject to site-specific analysis prior to approval or authorization.

2.2.3 Alternative C

The goal for Alternative C is to protect wildlife and other natural resources while allowing for the extraction of natural gas resources. Under Alternative C the operators would be approved to develop natural gas resource from the desired target formations, however all activities would be subject to resource development and protection measures intended to maintain or enhance

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

resource values. Approximately 95 percent of the federal lands within the project area would be assigned one or more resource protection measures to be applied to natural gas development activities. Resource protection measures would be applied based on the site-specific locations of the activity such as well development or construction of ancillary production facilities. Resource data, in the form of geographic information system (GIS) layers coupled with on-site reviews, would be used to identify specific areas of resource concern at the site-specific level. Examples of such resource concerns are sensitive wildlife and fish habitat and areas with sensitive soils. These resources are sufficiently unique to require additional protective measures beyond what is already provided by applying required BMPs (appendices H and J), lease stipulations, and conditions of approval (COA). As an end product, GIS layers would be available to operators for development of site-specific proposals for their annual work program during the Application for Permit to Drill (APD) process.

Below is a summary of development protection measures that would be implemented in some locations based on the presence of resources. A detailed description of protection measures is provided in appendix L, including references to maps (appendix M) depicting areas where the measures might be applicable and the rationale for the measure or resource concern that the measure would address or resolve.

- **Water and Soil Management.** In order to reduce salt and sediment loading in the Colorado River Basin, a resource management concern since the 1930s, no pad, compressor, or water transfer sites would be located in areas with steep slopes (>25%) or close to (within 500 feet) perennial waters or wetlands. Interim reclamation would be completed within 1 year of the spud date in areas with soils with excess salts and poor top soils, since these areas are more difficult to reclaim. Low-impact road design would be implemented in areas where soils have excess salts, high runoff potential, and severe road rating. Specifications for road construction and annual maintenance to reduce dust would be implemented in areas that have soils with excess salts and in areas with a severe road rating because these areas would generally have a higher clay or salt content in the soils and hence be more prone to dust problems. Special measures would be implemented in areas with high runoff potential to reduce surface water concentration, increase infiltration, and achieve reclamation success. Areas with high runoff potential would also have reduced surface disturbance (less than 20 acres and four well locations per section).
- **Vegetation Resources.** In difficult to reclaim vegetation communities with greater than 8-percent slopes, surface disturbance would be limited. Surface disturbance of more than 20 acres in size would not be allowed, and no more than 4 well pads per 640 acre section would be approved. In vegetation communities with high wildlife values or rare vegetation communities, no surface disturbance would be allowed. Silver sagebrush/bitterbrush communities would have limited areal extent of surface disturbance. All these communities within crucial winter range failed the Upper Colorado River Basin Standards and Guidelines Assessment (USDI-BLM 2002e). These areas would continue to fail standards without additional development protection measures.
- **Range Resources.** To protect range resources, operators would be required to ensure that their employees and subcontractors abide by speed limits and erect signs warning drivers of livestock concentration areas, such as lambing grounds and shipping pastures. Annual planning efforts would provide data to enable livestock

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

planning specific to pastures or allotment boundaries. Construction specifications would be put in place to reduce dust.

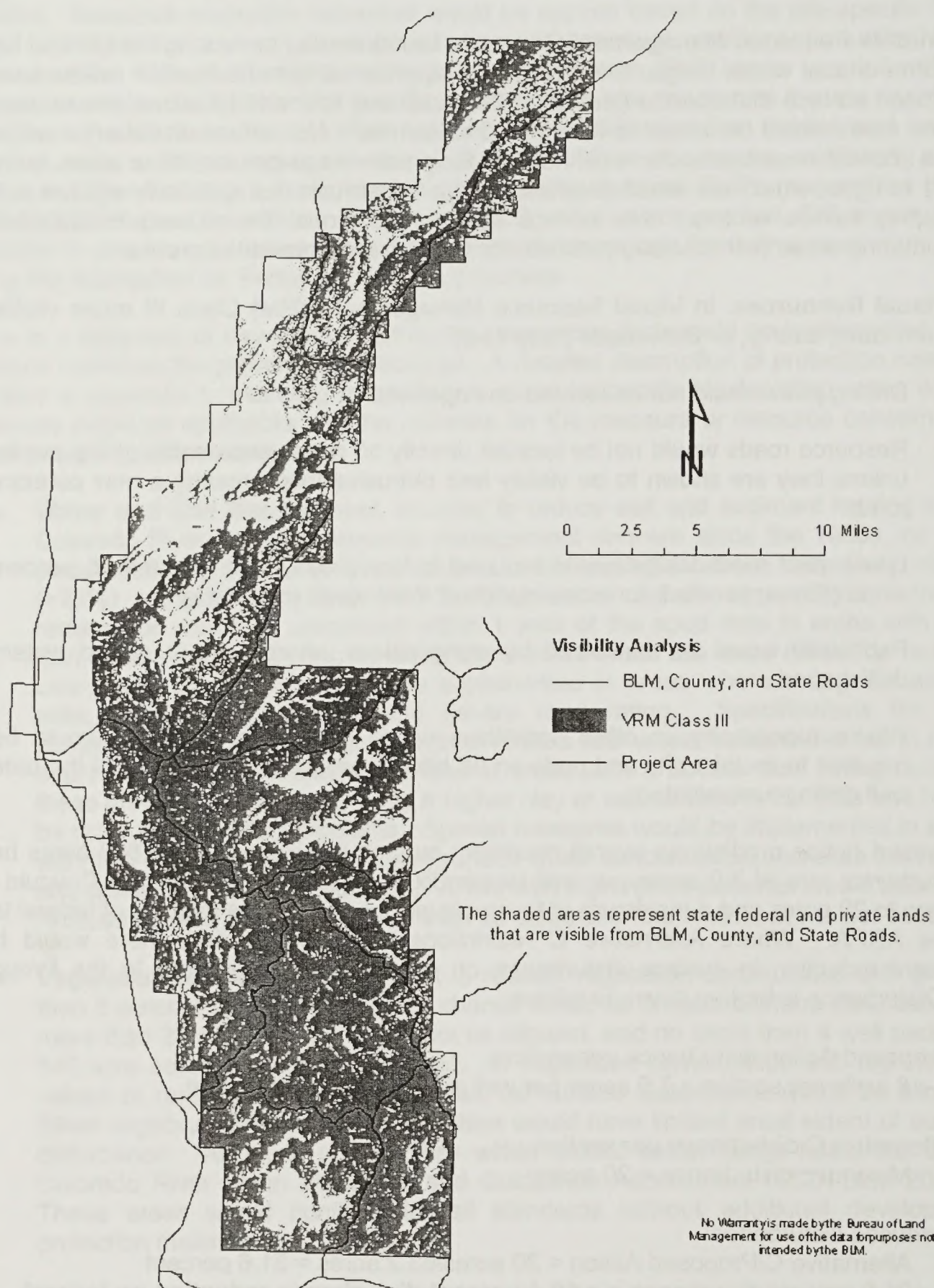
- **Wildlife Resource Management.** In grouse brood-rearing or nesting habitat and big game crucial winter range, the BLM would approve at the site-specific review level limited surface disturbance (less than 20 acres and four well locations per section) and roads would be limited to less than 3 miles/mile². No surface disturbance would be allowed in severe winter relief habitats for greater sage-grouse; these areas serve as refuges, which are small patches of high sagebrush that generally will not drift during severe winters. No surface disturbance would be allowed in identified wintering areas (serviceberry patches) for Columbian sharp-tailed grouse.
- **Visual Resources.** In Visual Resource Management (VRM) Class III areas visible from state, county, or BLM roads (map M-6):
 - Drilling pads would not be located on ridgelines;
 - Resource roads would not be located directly off roads assessable to the public, unless they are shown to be visibly less obtrusive than creating a new collector road;
 - Low-impact road design would be used in topography with less than 5 percent slope (See appendix L for a description of low-impact road design);
 - Pad sizes would be minimized by using pitless, shared pit, or closed-system drilling; and
 - Where topography or other conditions would allow, the operators would be required to reclaim pits and pads on an interim basis within one year of the date well drilling was initiated.

The Proposed Action predicts an overall maximum surface disturbance of 15,800 acres based on a disturbance rate of 7.9 acres per well (appendix K, table K-1). Alternative C would limit disturbance to 20 acres and a maximum of four wells per section on the majority of federal lands within the ARPA. Where Alternative C restrictions would be applied, there would be a 68.4-percent reduction in surface disturbance on federal lands compared to the Proposed Action. Disturbance is broken down as follows:

- Proposed Action disturbance per section:
 - 8 wells per section x 7.9 acres per well = 63.2 acres disturbance
- Alternative C disturbance per section:
 - Maximum disturbance = 20 acres
- Reduced disturbance:
 - Alternative C/Proposed Action = 20 acres/63.2 acres = 31.6 percent
 - 31.6 percent disturbance = a **68.4-percent disturbance reduction on federal lands**

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Map M-6. ARPA Visible from Main Roads in VRM Class III.



CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This reduction in surface disturbance is based on a section-by-section comparison where Alternative C restrictions are applied rather than requirements under the Proposed Action. In terms of effects at a larger scale, this percentage would decrease based on the amount of lands not affected by Alternative C requirements in the assessment area. Alternative C surface disturbance limitations would not apply on privately and state-owned lands. As a result, this percentage reduction would be the highest on blocked federal lands and vary greatly where interspersed federal and private lands coexist, especially in the checkerboard ownership pattern (map M-3).

The percentage of overall reduction in surface disturbance due to Alternative C restrictions is not predictable for the ARPA. Due to the variables inherent in a field development, it is not possible to predict specifically where optimal gas development will occur within the ARPA. Important variables in this percentage estimate are the number of wells proposed for siting in areas affected by development protection measures, the number of wells proposed on federal lands as opposed to private and state lands, and the amount of disturbance relocated to private lands to reduce effects on federal lands. Based on these uncertainties, total surface disturbance for the project could be similar under Alternative C as with the Proposed Action. Alternative C may shift disturbance from more sensitive resource areas to less sensitive areas. For the purposes of the EIS impact analysis, BLM developed an estimate of surface disturbance for Alternative C based on the following assumptions regarding potential development in the ARPA:

- All lands within the ARPA have an equal likelihood of producing natural gas.
- Development would be maximized on state and fee minerals by drilling 8 wells per section on all state and fee sections within the ARPA. Surface disturbance on these lands would average 7.9 acres/well (per the Detailed Proposed Action in appendix K).
- Development of the remainder of the 2,000 wells would occur on federal minerals at a density of 4 wells per section and 20 acres of disturbance per section. BLM assumed all federal minerals would be subject to the 4 well per section spacing requirement.

Based on these assumptions BLM estimated a maximum surface disturbance under Alternative C of 13,286 acres (table 2-1).

Under Alternative C, when annual site-specific development proposals are received, they will be reviewed on site by a team of IDT specialists. Based on the conditions found at the individual sites, development protection measures, BMPs, and COAs will be added to APDs before their approval.

2.2.4 Alternative D—the BLM's Preferred Alternative

The objective of this alternative is to minimize surface disturbance while optimizing natural gas recovery. Annual planning (as in the Proposed Action) between the operators and the BLM will be a key component of this alternative. Annual planning would require that each operator submit to the BLM their proposed plan of operation for the forthcoming year. The annual planning process would be used to discuss current and multi-year development plans with the intent of reducing disturbance within the ARPA. The BLM will then work with the operators and

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

interested agencies at a site specific level to minimize surface disturbance by applying the appropriate lease stipulations, COAs, BMPs, and any other measures deemed necessary to minimize surface disturbance and still allow for the full recovery of natural gas. The pace of development analyzed is the same as the Proposed Action (figure 2-1 of the Final EIS).

This alternative will limit initial site disturbance from all oil and gas development activities (resource roads, well sites, gas gathering pipelines, compressor stations, etc.) by establishing an average short term disturbance goal of 6.5 acres per well constructed. Limited disturbance per well would require less reclamation be completed by the operators and less land taken out of productivity. Natural gas development would be limited to 8 well sites per section, which includes CBNG, conventional, and injection wells. Operators could install multiple well bores (e.g. CBNG, conventional or injection) on a well site.

Total surface disturbance under Alternative D would be approximately 13,600 acres (2,000 wells x 6.5 acres/well, plus approximately 600 acres existing disturbance under the Interim Drilling Policy). For the overall Atlantic Rim area, no more than 7,600 acres (2.8% of the project area) would be disturbed and unreclaimed at any time. If the disturbance limit should be reached, further disturbance activities would be halted pending successful reclamation. Upon reclamation success further natural gas development proposals would be considered and approved without exceeding the disturbance limit. The standard for "reclamation success" is defined in the Final EIS Reclamation Plan (appendix B) under "Criteria for Reclamation Success".

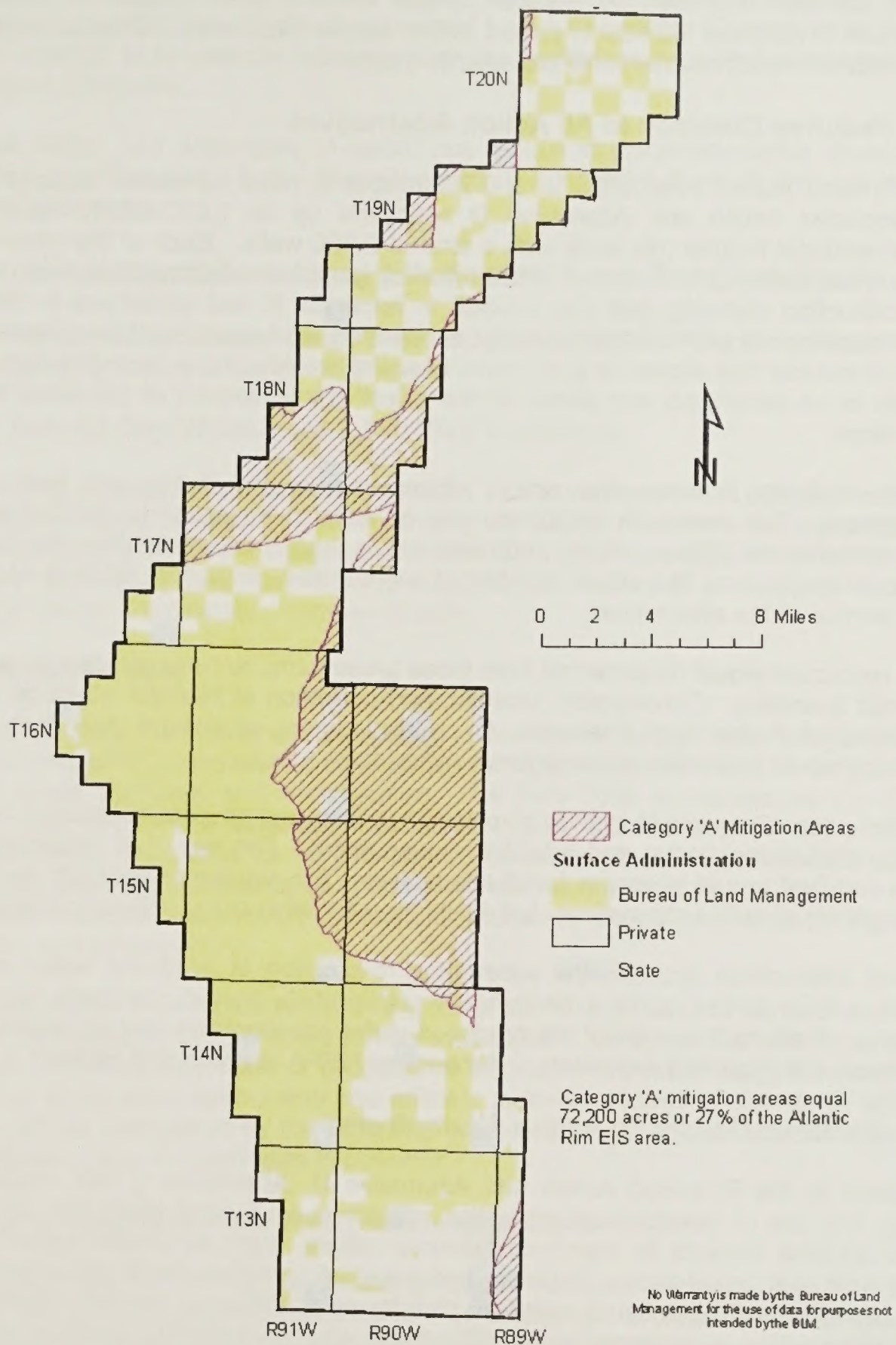
A map of the existing disturbance associated with activities authorized as part of the interim drilling policy would be prepared. This map will serve as the baseline level of disturbance and would be updated annually. The BLM would track both the planned versus actual disturbance on an annual basis as well as the cumulative, un-reclaimed surface disturbance.

Within Atlantic Rim those areas designated as "Category A" would be managed more intensely (utilizing appropriate lease stipulations, COAs and BMPs) to reduce the extent of disturbance below an average of 6.5 acres / well. Reduced disturbance below 6.5 acres / well, coupled with successful reclamation within Category A will be considered when evaluating development proposals outside the area. Category A, as depicted on map M-7, includes management areas with sensitive fish populations, and crucial wildlife habitats, including areas of critical environmental concern, special management areas (SMA), elk crucial winter range and silver sage/bitterbrush communities. Category A is about 72,200 acres in extent.

Disturbance levels would be determined through geo-spatial information regarding areas actually disturbed provided annually by the operators in conjunction with the Final EIS Reclamation Plan (appendix B). Reclamation would be reviewed, at a minimum, annually. For those areas needing further work, adaptive management using appropriate BMPs would be implemented to ensure subsequent reclamation success. Developers would propose and implement reclamation measures that would be used for both areas with reclamation problems and newly disturbed areas.

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Map M-7. Alternative D with Category A Mitigation Areas.



CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.3 Comparison of Alternatives

The four alternatives evaluated in this EIS are compared in this section, first by the features they have in common and then by features unique to each one. Table 2-1 provides a brief comparison of potential impacts to project issues across alternatives. Greater detail is provided in the detailed impact assessments provided in chapter 4.

2.3.1 Features Common to All Action Alternatives

The Proposed Action, Alternative C, and Alternative D have numerous features in common. The Proposed Action and Alternative D anticipate up to 1,800 CBNG wells and up to 200 conventional natural gas wells with a total of 2,000 wells. Each of the alternatives would utilize annual planning for approval of the following years' development activities, as detailed in "Preconstruction Planning and Site Layout" in appendix K and elsewhere in this document. Annual planning will provide for the receipt, processing, and approval of development proposals in such a manner that allows for economies of scale, provides for a more thorough appraisal of the work to be performed, and allows for the effective involvement of interested agencies and cooperators.

Another similarity between the action alternatives is the timing and rate of gas well development. The maximum annual number of wells to be drilled is detailed on figure 2-1. While economic conditions, drill rig and construction equipment availability, weather, and other conditions could lower the actual number of wells drilled, any such effect is expected to be similar across all the alternatives.

CBNG resources would be extracted from those areas found to have natural gas in feasible and economic quantities. Construction, location, and operation of facilities would be similar under the Proposed Action and Alternative D. Development of natural gas from conventional formations would be similar under all three alternatives.

All action alternatives would include a reclamation plan and process dependent on geo-spatial tracking, annual monitoring and adaptive management. The timing of reclamation, including interim and final, would be similar for all alternatives. The number of wells per section would be up to eight for all action alternatives, but would be reduced in many areas for Alternative C.

All three alternatives propose the subsurface re-injection of produced water as a disposal method, with a limited surface discharge under permits issued previously by the State of Wyoming. If alternative uses of the produced water are identified and proposed, they can be considered and approved separately under another NEPA analysis and decision.

2.3.2 Features Unique To Action Alternatives

Compared to the Proposed Action and Alternative D, Alternative C has unique provisions; namely, the use of development protection measures on federal lands that are designed to reduce adverse impacts to important resource values, such as crucial winter range, sage-grouse nest and brood-rearing habitats, and areas of sensitive visual and cultural resources. Areas of high runoff potential or soils with high levels of salinity or that are alkaline, and areas where reclamation is expected to be difficult are also considered "sensitive resources". In addition, the extent and scale of the various development protection measures would limit surface disturbance and well pad locations to four or less across broad expanses of the ARPA.

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

While Alternative C analyzes up to 2,000 wells, the precise number that can be approved under the alternative could be less depending on the specific locations at which development is proposed. Development could be limited to four well locations per section in up to 95 percent of the federal lands within ARPA. The exact degree of constraint would depend on the site-specific locations proposed annually for development by the operators. Comments to the Draft EIS and from internal BLM sources indicates that this limited amount of development might render the project unfeasible.

The Proposed Action and Alternative D would not reduce development using development protection measures. Compared to the Proposed Action, Alternative D would limit unreclaimed disturbance to 7,600 acres.

2.4 Alternatives Considered and Eliminated from Detailed Study

Four alternatives were considered and eliminated from detailed study. The alternatives and the reasons for eliminating them are described below.

2.4.1 3,880 Natural Gas Wells from 3,880 Well Locations

During the scoping process, the operators estimated that a maximum of 3,880 gas wells from 3,880 well locations would be required to fully develop the ARPA. Based on the exploration and development activities permitted between 2001 and 2006, the operators have revised their original estimate of needing 3,880 gas wells to maximize the economic recovery of the natural gas resource to the current proposed number of wells.

2.4.2 Directional Drilling

Mandatory use of directional drilling was suggested in comments during the scoping process as a way to reduce habitat loss and wildlife disturbance by reducing the numbers of well pads and corresponding roads, pipelines, and infrastructure. In a June 2005 memorandum, the RMG of the Wyoming BLM stated that extensive directional drilling did not appear to be a viable technical or economic alternative for natural gas extraction in the ARPA. Mandatory use of directional drilling was suggested in scoping and comments to the Draft EIS as a way to reduce habitat loss and wildlife disturbance by reducing the numbers of well pads and corresponding roads, pipelines, and infrastructure.

Requiring the operators to use directional drilling for all wells regardless of surface conditions, topography, or subsurface geology would not be reasonable. Using such a technique without regard for local conditions may deter or preclude an operator from maximizing the recovery of the gas resource in the most economical and efficient manner. However, directional drilling is an option that can be considered by the BLM and the operators where surface conditions and resource constraints make it reasonable to consider.

2.4.3 Produced Water Disposal and Treatment Options

The operators proposed re-injecting wastewater produced during development and operation of each gas well. Some of the produced water would be discharged in regulated tanks for use by wildlife and livestock. Several alternatives to re-injecting water were considered:

- Water treatment with discharge onto land surface,

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

- Surface discharge without treatment,
- Storage in evaporation/infiltration ponds, and
- Transmission of produced water by pipeline from the Colorado River watershed to either the Great Divide Basin or North Platte River watershed with discharge onto land surfaces.

Produced wastewater has varying concentrations of minerals and salts, and usually needs treatment to make it usable or to meet water quality standards. For example, under a policy adopted on October 30, 2002 by the Colorado River Basin Salinity Control Forum, entitled "Policy For Implementation of Colorado River Salinity Standards Through the NPDES Permit Program 1", water discharged within the watershed must not add more than 1 ton per day or 366 tons per year of salts to the Colorado River system. The preferred method of disposal would be re-injecting the produced water back into other geologic formations adjacent to or near the producing formation in places where the local geology lends itself to this method. Other methods of disposal, especially when the wastewater must be treated, transported, or both, tend to be more costly and might have inherent logistical and engineering problems. Because of these reasons, other wastewater disposal alternatives were eliminated from detailed study.

The Proposed Action includes re-injection of produced water, with the exception of limited closed water discharge into regulated troughs or tanks for livestock and wildlife drinking water and a limited surface discharge under existing State of Wyoming permits. Re-injection of produced water removes the water from coal seams and places it into geologic formations as permitted by the State of Wyoming. Re-injection avoids surface impacts from the produced water including erosion, changes to vegetation communities, and salinity issues relating to water release within the Colorado River Basin. Beneficial uses of ARPA-produced water, while not identified or proposed at this time, may come forward in the future. When and if such proposals are made, State of Wyoming approval under the State's various permitting authorities would be required. In addition, the BLM would review and approve or disapprove any such proposal based on the specifics of the proposal and the BLM's authorities and responsibilities under NEPA and FLPMA.

2.4.4 Alternative B

Alternative B proposed that natural gas development activities would be restricted to one of three zones within the ARPA boundary at any one time. Each zone would be open to construction and development of natural gas removal and processing facilities for 7 years at which time construction and development activities would cease. Gas extraction and processing would continue (i.e., operational activities), while construction and development activities would move to another zone. The intent of the alternative was to focus disturbance activities into a smaller area while the remainder of the project area would be less disturbed and less impacted than under the proposed action.

Significant effects were expected under this alternative upon several resources including wildlife, soils and range. Comments received from the companies objected to the extended delay to their ability to develop their leases in those areas not open to development activities for 7 to 14 years. In addition comments pointed out the implication that BLM would not approve rights-of-way proposals for the development of private and state oil and gas development within the closed areas conflicts with BLM policy (BLM Manual, Part 2800.06 "Policy" (D)) to allow

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

owners of non-federal lands surrounded by public lands managed under FLPMA that would provide for the reasonable use and enjoyment of the non-federal land. A large portion of the project area is located in a so-called “checkerboard” ownership pattern of alternating federal and private / state lands where access to such lands requires federal rights-of-way approval for access.

Alternative B was eliminated from further detailed study in the Final EIS based on comments received on the Draft EIS, the effects of long delays on allowable oil and gas development to leaseholders and mineral rights, and the policy that BLM will allow reasonable access across federal lands for mineral development on private and state lands.

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Table 2-1. Brief Comparison of Impacts to Key Issues across Alternatives.

Key Issue	Proposed Action	Alternative A (No Action)	Alternative C	Alternative D
Disturbance				
Initial acres of new surface disturbance (IDP)	15,800 (600)	(600)	13,286 (600)	13,000 (600)
Total acres new disturbance (at any given time)	15,800	0	13,286 ^{1,2}	7,600 ³
New long-term surface disturbance	6,200	0	6,200 ²	5,000
Total Well Pads (IDP)	2,000 (116)	(116)	1,130 ⁵ – 2,000 (116)	2,000 (116)
New Roads (miles)	1,000	-	1,000 ²	1,000
Average Daily Traffic Volume (round trips to and from the ARPA per day)	350–430		350–430	350–430
Project Duration/Pace/Economics				
Life of project (years)	30–50	10–30	30–50	30–50
Wells developed per year	200 (max)	-	200 (max)	200 (max)
Peak project-related employment (year 5)	1,488	-	937 ⁸ –1,488	1,488
Total taxes and royalties (millions)	958	62 ⁷	62 / 603 ⁶ / 776	958
Carbon county share (millions)	105	7 ⁷	7 / 66 ⁶ / 85	105
Livestock management				
Initial Loss (AUMs)	2,026	150-200	1,703	1,667
Loss from Dust and Weeds (AUMs)	3,588–5,588		3–6,000	3,588–5,588
Temporary Non-Use Permits (AUMs)	20,000		5–10,000	20,000
Air Quality/Visibility per Year				
Additional days of visibility impairment per year at nine sensitive PSD Class I and Class II areas	0	0	0	0
Number of lakes sensitive to atmospheric deposition impacts above identified limits of acceptable change	0	0	0	0

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Table 2-1. Brief Comparison of Impacts to Key Issues across Alternatives.

Key Issue	Proposed Action	Alternative A (No Action)	Alternative C	Alternative D
Mineral Resource Recovery				
Natural Gas (billion cubic feet)	1,350 ⁴	87 ⁴	87 / 850 / 1,100 ^{5, 6}	1,350 ⁴

Habitat Loss All Species

- *Direct habitat loss for greater sage-grouse, pronghorn antelope, and other wildlife would be related to surface disturbance and project duration as listed above. Most wildlife species would likely avoid development areas under all alternatives.*
- *Indirect habitat loss for greater sage-grouse, pronghorn antelope, and other wildlife would be related to total surface disturbance (and its location), volume of human presence (worker-years), and project duration, as listed above.*
- *An overall surface disturbance reduction percentage for the ARPA from Alternative C was predicted based on the assumptions discussed in section 2.2.3, Alternative C. Alternative C may shift disturbance from more sensitive resource areas to less sensitive areas and from federal lands to state and fee lands.*

Notes:

AUM - animal unit month

1. Alternative C estimates assume successful development on federal minerals at 160-acre spacing. IDP data and evaluations by petroleum reservoir professionals indicate that economic gas volumes may not be recoverable at 160-acre spacing and that 80-acre spacing at the reservoir level is required.
2. Protective measures included in Alternative C may shift surface disturbance from higher sensitivity areas on federal minerals to lower sensitivity areas. These protective measures may also shift surface disturbance from federal minerals to state and fee minerals.
3. Unreclaimed surface disturbance under Alternative D is limited to 2.8 percent of the ARPA (7,600 acres); and more intensive management of the Category A areas through a goal of less than 6.5 acres per well average surface disturbance.
4. Estimated natural gas recovery is for 1,800 CBNG wells only, at 0.750 mmcf / well. Estimated gas recovery for conventional wells was not provided by the applicant (section 4.12).
5. For comparison purposes gas recovery under Alternative C assumes 670 CBNG wells on federal minerals at 160 acre spacing with 50 percent of the recovered gas volume compared to 80 acre spacing. Also see Note #1 (Max. state/fee minerals: 141 sections x 8 wells per section = 1,130 wells; 1,800 CBNG wells--1,130 state/fee = 670 CBNG well on federal minerals).
6. Alternative C recovery, tax and royalties estimates include: 1) IDP production only, 2) development on state/fee minerals only (1,130 well or 63 percent of the 1,800 CBNG wells included in the Proposed Action) and 3) 1,130 wells on state/fee minerals at 80 acre spacing and 670 CBNG wells on federal minerals at 160 acre spacing (also see Note #5).
7. No Action estimate assumes 116 wells producing from the IDP with average gas recovery of 0.750 mmcf / well (e.g. equivalent to 6.4 percent of the Proposed Action).
8. Alternative C project related employment reflects a range from drilling on state and fee minerals only (1,130 wells or 63% or the Proposed Action, also see Note #6) to drilling 2,000 wells.

Chapter 3

Affected Environment

3 Affected Environment

This chapter discusses environmental, social, and economic factors as they currently exist within the ARPA. The material presented here has been guided by management issues identified by the BLM RFO, public scoping, and by IDT analysis of the area.

The Proposed Action could potentially affect critical elements of the human environment as listed in BLM's NEPA Handbook H-1790-1 (USDI-BLM 1988). The critical elements of the human environment, their status in the ARPA and their potential to be affected by the proposed project are listed in table 3-1.

Table 3-1. Critical Elements of the Human Environment¹.

Element	Status on the ARPA	Addressed in text of EIS
Air quality	Potentially affected	Yes
Areas of critical environmental concern	Potentially affected	Yes
Cultural resources	Potentially affected	Yes
Environmental justice	Potentially affected	Yes
Prime or unique farmlands	None present	No
Floodplains	Potentially affected	Yes
Native American religious concerns	Potentially affected	Yes
Noxious weeds	Potentially affected	Yes
Threatened and endangered species	Potentially affected	Yes
Hazardous or solid wastes	Potentially affected	Yes
Water quality (surface and ground water)	Potentially affected	Yes
Wild and scenic rivers	None present	No
Wetlands/riparian zones	Potentially affected	Yes
Wilderness	None present	No

Note:

¹ As listed in BLM *National Environmental Policy Act Handbook H-1790-1* (USDI-BLM 1988) and subsequent Executive Order

In addition to the critical elements, this EIS discusses potential effects of the project on geology, paleontology, and minerals; soils; water resources; vegetation; wildlife; special status species; noise; visual resources; recreation; and socioeconomic considerations.

3.1 Geology, Mineral, and Paleontology Resources

3.1.1 Geology Resources

To describe the geologic resources in the ARPA, regional geology is overviewed, followed by a discussion of Quaternary Deposits and Geologic Hazards.

3.1.1.1 Regional Geologic Overview

The ARPA straddles the west margin of the Continental Divide and lies within the southeastern arm of the Great Divide Basin sub-basin region of the Greater Green River Basin (Bradley 1964) of southernmost central Wyoming. Structurally, rocks in the ARPA dip generally northwest, west, and southwest off the arcuate structural high of the Sierra Madre Range westward into the eastern edges of the Greater Green River and Washakie structural basins.

The west flank of the Sierra Madre is bounded by a major eastward-dipping reverse fault system that was elevated over the eastern edge of the Greater Green River Basin (including the Washakie Basin) during the Laramide Orogeny (late Cretaceous to Early Tertiary time). These reverse faults are not exposed at the surface, but rather lie buried beneath Early Tertiary sediments filling the basin. The Washakie Basin to the west, into which the surface rocks dip, is bound by east-west oriented structural highs, the Wamsutter Arch and Cherokee Ridge to the north and south, respectively. The structural axis of Cherokee Ridge trends along the Wyoming-Colorado state line and separates the extreme southeastern arm of the Greater Green River Basin of Wyoming from the Sand Wash Basin of Colorado. Numerous faults occur along Cherokee Ridge, many of which show evidence of recurrent motion throughout the last 20 million years. None of these, however, show any indication of Quaternary movement (Case et al. 1994).

Geologic mapping by the United States Geological Survey (USGS) and Wyoming Geologic Survey documents that rocks that crop out on the surface in the ARPA include sedimentary deposits of Quaternary, Tertiary, and Late Cretaceous ages (Weitz and Love 1952, Love 1970, Love and Christiansen 1985, Love et al. 1993, and Roehler 1973, 1977, and 1985). These deposits are underlain by Phanerozoic age sedimentary rocks of Cretaceous to Cambrian age, which are in turn underlain by Precambrian metamorphic bedrock that comprises part of the ancient North American craton and exceeds 2 billion years in age.

Information on geologic units preserved at the surface and beneath the ARPA is provided in table 3-2. Rock terminology for the Cretaceous (Mesaverde Group) is complicated in that scientific studies of these rocks reference a number of different formations within the ARPA. Although the Wyoming Chart of Stratigraphic Nomenclature lists the Almond, Ericson, Rock Springs, and Blair formations within the Mesaverde Group in the Washakie Basin, alternative terminology has been used for these same rocks by authors describing the coals of the Mesaverde Group. Rock-equivalent names for the Ericson Sandstone include the Williams Fork Formation or Pine Ridge Sandstone; for the Rock Springs Formation, the Allen Ridge Sandstone; and for the Blair Formation, the Haystack Mountain Formation.

Additional details on surface deposits are provided below.

Table 3-2. Surface and Subsurface Geologic Deposits within the Atlantic Rim Project Area.

Geologic Deposit	Geologic Age	Environment/Lithology	Resources
Surface Deposits			
Unnamed Quaternary Deposits	Holocene-Pleistocene	Eolian/fluvial/landslide. Sand, gravel, clays, weathered in place residuum from exposed outcrops.	None reported within area, economic deposits of windblown sand reported 20–30 miles NNE of the town of Baggs, Wyoming, just east of the project area.
Browns Park Formation	Miocene	Alluvial fan/volcanic, Polymictic conglomerates, tuffaceous sandstone and mudstones.	Vertebrate and plant fossils (BLM Condition 2). No mineral resources reported within area. Uranium produced in adjacent areas (Ketchum Buttes, Miller Hill, Poison Basin).
Wasatch Formation	Early Eocene	Terrestrial: fluvial/floodplain/swamp, drab to varicolored mudstone, sandstone, carbonaceous shale, and coal.	Vertebrate, invertebrate, and plant fossils (BLM Condition 2). Coal. Petroleum in subsurface. Uranium reported in adjacent areas near Wamsutter Creston and Latham.
Fort Union Formation	Paleocene	Terrestrial: fluvial/floodplain/swamp, chiefly somber colored sandstones, mudstones, carbonaceous shales, and coals.	Vertebrate, invertebrate, and plant fossils (BLM Condition 2); coal; and coal bed natural gas.
Lance Formation	Late Cretaceous	Terrestrial: fluvial/floodplain/swamp, brown and gray sandstone, shale and mudstone, coals, and carbonaceous shales.	Vertebrate, invertebrate, and plant fossils (BLM Condition 2); coal; and coal bed natural gas.
Fox Hills Sandstone	Late Cretaceous	Marine: shoreline, light-colored sandstone and gray sandy shale.	Vertebrate and invertebrate fossils (BLM Condition 3). No minerals resources reported.
Lewis Shale	Late Cretaceous	Marine: near shore to offshore, gray shale containing gray, brown sandstones.	Invertebrate fossils. Petroleum in Espy Field.

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-2. Surface and Subsurface Geologic Deposits within the Atlantic Rim Project Area.

Geologic Deposit		Geologic Age	Environment/Lithology	Resources
Mesaverde Group	Almond Formation	Late Cretaceous	Marine, terrestrial, deltaic: white and brown sandstone, sandy shale, coal, and carbonaceous shale.	Vertebrate, invertebrate, and plant fossils (BLM Condition 2); coal; and coal bed natural gas. Natural gas and liquid hydrocarbons in Baldy Butte, Cherokee Creek, Cow Creek, Creston, Deep Gulch, Espy, Savery Fields.
	Ericson Sandstone (=Pine Ridge or Williams Fork Formation)	Late Cretaceous	Marine: coastal plain, estuary/beach, white sandstone, lenticular conglomerate, coal.	
	Rock Springs (=Allen Ridge or Iles) Formation	Late Cretaceous	Terrestrial, coastal plain white to brown sandstone, shale, mudstone, coal.	
	Blair (=Haystack Mountains) Formation	Late Cretaceous	Shallow marine: alternating sandy shale and ripple marked sandstone.	
Subsurface				
Steele Shale (includes Shannon and Sussex Sandstones)		Late Cretaceous	Marine, gray shale, with numerous bentonites, sandstone.	Natural gas and liquid hydrocarbons in Browning Cherokee Creek, Cow Creek, Deep Creek, Deep Gulch, Sierra Madre Fields.
Niobrara Formation		Late Cretaceous	Marine, light-colored limestone, gray limey shale.	Natural gas and liquid hydrocarbons in Espy Field.
Frontier Formation		Late Cretaceous	Marine: deltaic, gray sandstone and sandy shale.	Natural gas and liquid hydrocarbons in Browns Hill, Cherokee Creek, Cow Creek, Deep Gulch, Sugar Creek Fields.
Mowry Shale		Late Cretaceous	Marine: silver-gray, hard siliceous shale, with abundant fish scales and bentonites.	Bentonites mined about 10 miles east of area.
Muddy Sandstone		Early Cretaceous	Marine: deltaic, gray to brown sandstone, conglomeratic.	Natural gas and liquid hydrocarbons in Browning, Deep Creek, Sugar Creek Fields.

Table 3-2. Surface and Subsurface Geologic Deposits within the Atlantic Rim Project Area.

Geologic Deposit	Geologic Age	Environment/Lithology	Resources
Thermopolis Shale	Early Cretaceous	Marine, black, soft fissile shale.	None reported, oil and source rock.
Cloverly Formation (=Dakota Sandstone)	Early Cretaceous	Terrestrial, variegated mudstone, bentonitic, conglomeratic sandstone.	Natural gas and liquid hydrocarbons in Browning, Cherokee Creek Fields.
Morrison Formation	Jurassic	Terrestrial, varicolored mudstones, white sandstone, bentonite.	Natural gas and liquid hydrocarbons in Browning Field.
Sundance Formation	Jurassic	Marine, green-gray glauconitic sandstone and shale, underlain by red and gray non-glauconitic shale and sandstone.	None reported
Nugget Sandstone	Triassic to Jurassic	Eolian, gray to red, massive to cross-bedded sandstone.	Natural gas and liquid hydrocarbons in Cow Creek, Deep Gulch Fields.
Chugwater Formation	Triassic	Terrestrial/mud flat, red shale and siltstone, sandstone.	Natural gas and liquid hydrocarbons in Browning Field.
Goose Egg Formation	Permian to Triassic	Marine, gray to olive dolomitic siltstone, red sandstone and siltstone, gypsum, halite, purple to white dolomite, and limestone.	None reported
Tensleep Sandstone	Pennsylvanian	Marine, white to gray sandstone with limestone and dolomite.	Natural gas and liquid hydrocarbons in Browning, Espy, Sugar Creek Fields.
Amsden Formation	Mississippian to Pennsylvanian	Marine, red and green shale and dolomite, persistent red to brown sandstone at base.	None reported
Madison Limestone	Mississippian	Marine, blue-gray massive limestone and dolomite.	None reported
Flathead Sandstone	Cambrian	Marine/shoreline, red, banded, quartzose sandstone.	None reported
Unnamed metamorphic rocks	Precambrian	Igneous/metamorphic, granitic and/or intrusive.	None in area but in Sierra Madre contain ores of uranium, copper, silver, lead, zinc, gold, and barium industrial (building and decorative) grades of quartzite, marble, and granite.

3.1.1.2 Quaternary Deposits

Quaternary deposits in the ARPA include widespread deposits of alluvium, colluvium, and slope wash; eolian sand dunes; residuum developed on formations of Cretaceous (Lance and Lewis Formation and Mesaverde Group), Paleocene (Fort Union Formation), and Eocene (Wasatch Formation) ages; and mass movement (including landslide) debris.

Tertiary: Browns Park Formation

The Miocene Browns Park Formation unconformably overlies all older rocks exposed at the surface within the ARPA, with its largest area of outcrop developed in the S1/2, T13N:R90W, where it overlies the Lewis Shale, Lance, Fort Union, and Wasatch Formations with angular unconformity. The Browns Park Formation continues north into the E1/3 of T14N:R90W and the SE1/4 T15N:R90W, where it overlies the Mesaverde Group and Lewis Shale. Two large outliers of Browns Park Formation cap ridges form the highest elevations in the ARPA: in the SE1/4, T17N:R90W and the SE1/4, T18N:R90W, where they overlie truncated hogbacks expressed in the Mesaverde Group. Regionally, the Browns Park Formation consists of up to 1,000 feet (305 meters) of polymictic conglomerate (especially at the base of the formation), derived from Precambrian and Paleozoic sources, and tuffaceous sandstones and mudstones (Ritzma 1949). Mudstones of the formation are known to be rich in montmorillonite; a swelling clay. As a result, it is extensively involved in mass movement (earth flow) in some areas.

Tertiary: Wasatch Formation

Outliers of Tertiary age rocks are exposed at three places within the ARPA: (1) just northeast of the town of Baggs in Section 35, T13N:R91W, where it overlies the Paleocene Fort Union Formation and (2) as two distinct outliers capping the highest hills in the E1/2, T14N:R91W, overlying rocks of the Upper Cretaceous Lance Formation and Lewis Shale with angular unconformity.

These outliers include flat-lying sandstones and variegated mudstones of obvious Tertiary age that lie with marked angular unconformity on underlying older rocks. Weitz and Love (1952) mapped the outlier rocks as the Wasatch Formation of Eocene age. Later, Love and Christiansen (1985) mapped them as rocks of the Browns Park Formation of Miocene age. The presence of well-indurated sandstones and variegated (including red) mudstones in these Tertiary deposits, which are like the Wasatch Formation (main body member) and very unlike the Browns Park Formation, suggests that the deposits are correctly identified as the Wasatch Formation. This interpretation is supported by the occurrence of rocks of the Wasatch Formation west of Wyoming State Highway 789 at Flat Top Mountain at the same elevation (about 7,200 feet above mean sea level [amsl]) as these outliers. The nearest rocks of the Browns Park Formation occur several miles to the east at much higher elevations (7,600+ feet amsl).

Regionally, the main body of the Wasatch Formation consists of up to 2,130 feet (650 meters) of drab to variegated mudstone, gray sandstone, carbonaceous shale, and coal that accumulated in alluvial channels and back swamps, as well as on more distal floodplains (Bradley 1964, Sullivan 1980, Roehler 1985). Mudstones and shales of the formation are readily eroded into badlands, but most of the sandstones are resistant and form prominent outcrops.

Tertiary: Fort Union Formation

The Paleocene Fort Union Formation is exposed in an arcuate outcrop that borders the entire western margin of the ARPA. Within this area proper, however, the formation is exposed only in

a few minor areas located in: the NE1/4, T13N:R91W and the C of T14N:R91W; in the NE1/4, T15N:R92W and the C of T16N:R92W; in the extreme NW1/4, T17N:R91W and NE1/4, T18N:R91W; and in the SW1/4, T19N:R90W.

Regionally, the Fort Union consists of up to 3,400 feet (1,037 meters) of discontinuous drab mudstones, sandstones, carbonaceous shales, and coal that accumulated in alluvial channels and floodplain back swamps (Sanders 1975). As much as 1,500 feet (457 meters) of Fort Union are exposed in the Riner Quadrangle, a few miles north of the project area (Sanders 1974). Like the Wasatch Formation, mudstones and shales of the formation readily eroded into badlands in places, and the sandstones are relatively resistant and form prominent outcrops.

The contact of the Fort Union Formation with the underlying Upper Cretaceous Lance Formation is everywhere marked by a pronounced angular unconformity and generally a thick channel sandstone (Roehler 1993). It is unknown if the Tertiary-Cretaceous boundary is preserved in the area, but certainly earliest Paleocene rocks are (See section 3.1.3).

Upper Cretaceous: Lance Formation

The Latest Cretaceous Lance Formation consists of about 2,890 feet (881 meters) of interbedded gray sandstone and mudstone and carbonaceous shale and coal. The formation crops out over the majority of the western part of the ARPA (Hettinger et al. 1991, Hettinger and Kirschbaum 1991). Because the sandstones of the formation are relatively resistant to erosion, a series of resistant ridges and high cliffs or both are developed where the stratigraphy of the formation is dominated by them. In areas dominated by mudstones and shale, the formation is largely eroded flat and covered with soil and vegetation. In most places in the ARPA, the Lance does not have a tendency to erode into badlands.

Regionally, the Lance overlies the Fox Hills Sandstone (Smith, J.H. 1961, Gill et al. 1970, Hettinger et al. 1991, and Roehler 1993), which is included in the Lewis Shale on many maps. To the east, the Fox Hills may be absent, and the Lance may directly overlay the Lewis Shale (Weitz and Love 1952, Love and Christiansen 1985). Farther eastward, Lance rocks correlate with the Medicine Bow Formation (Merewether 1971) and, farther west, the Lance thins to less than 197 feet (60 meters) on the west side of the Washakie Basin (Roehler 1985).

Upper Cretaceous: Lewis Shale

The Lance Formation is underlain by the Lewis Shale. This relatively nonresistant unit occupies nearly all of the central part of the ARPA. The Lewis Shale consists chiefly of up to 1,500 feet (457 meters) of near-shore marine shale and thin, discontinuous stringer sandstones (Smith, J.H. 1961, Roehler 1993). With the exception of the uppermost part of the formation, which contains a series of laterally extensive sandstones that weather to ridges and small cliffs, the Lewis Shale is not very resistant to erosion and forms a broad strike valley.

The Lewis Shale interfingers westward into the upper part of the Mesaverde Group, the Fox Hills Sandstone, and the lower part of the Lance Formation. Within the ARPA, the Lewis Shale is underlain in surface sections by the Mesaverde Group; however, farther north and east (seaward), along the Sierra Madre Range and in the Laramie Basin, the Lewis Shale directly overlies the Steele Shale (Ritzma 1949, Roehler 1993).

Upper Cretaceous: Mesaverde Group

The Mesaverde Group is the oldest rock unit exposed within the ARPA and forms all surface outcrop of the eastern region of that area, with the exception of a few places where it is

unconformably overlain by much younger Miocene rocks of the Browns Park Formation. The group consists of 1,125 to 2,000 feet (343 to 610 meters) of massive beach and shelf sandstones, interbedded with minor amounts of shale, carbonaceous shale, mudstone, and coal. The upper part of the group is dominated by sandstones, which are relatively resistant to erosion, and form prominent dip slopes that dip westward forming the eastern boundary of the ARPA. Atlantic Rim, from which the project name is derived, is a series of these dip-slope sandstones developed in the northeastern part of the area.

In the ARPA region, the Mesaverde Group is subdivided into three formations, from top to bottom: the Almond Formation, the Ericson (aka, Pine Ridge) Sandstone, and the Rock Springs (aka, Allen Ridge) Formation (Roehler 1993). All of these units inter-tongue to the east and north with the Steele Shale. The Ericson Sandstone and Rock Springs Formation are the lateral equivalents of the Williams Fork Formation and Iles Formation, respectively, in the Sand Wash Basin of Colorado, which contain important coal and potentially important CBNG resources. The terminology *Williams Fork* and *Iles* formations have been extended into Wyoming by authors describing subsurface coal deposits.

3.1.1.3 Geologic Hazards

Of known naturally occurring geologic hazards—fault-generated earthquakes, floods, landslides, or other mass movements—the most likely to affect the project area are mass movements that could be initiated on steep slopes. There are no known faults with evidence of Quaternary movement or earthquake epicenters mapped within the area (NEIC 2003, WGS 2003). A 4.3-Richter magnitude earthquake occurred on April 4, 1999, a few miles northwest of the western boundary of the ARPA. The epicenter of this earthquake was located near Baldy Butte in T17N:R92W (41.45°N, 107.74°W). No other earthquake epicenters have been recorded in or immediately adjacent to the area in the past 100 years, indicating that this quake was probably an unusual event and that the area is not likely seismically active.

Pyrophoricity

Pyrophoricity (spontaneous combustion) has been cited as a potential hazard of coal gas development. Spontaneous combustion of coal has long been a concern for mankind and shallow coal mine fires in areas of abandoned mines are today still an environmental concern throughout the world (Lyman and Volkmer 2001).

Spontaneous combustion of coal is unlikely to occur in naturally exposed outcrops because, by the time coal is exposed by erosion, it has already degassed and cannot ignite spontaneously (Coates and Heffern 1999). However, the presence of naturally occurring outcrops of clinker and baked shale show that it has happened in the past in the ARPA. Studies of *in-situ* coal gasification conducted during the 1970s in Wyoming suggest that even under extreme efforts to maintain combustion (by injecting air into the burn zones) in underground coals ignited in boreholes, coal burning away from the ignition area cannot be sustained. Loss of permeability associated with plugging of fissures by tar and combustion products resulted in the fires burning themselves out rather quickly. In their study of Powder River Basin CBNG wells, Lyman and Volkmer (2001) found that spontaneous combustion of coalbeds during CBNG production is unlikely because the configuration of the well keeps air necessary for combustion out of the system. "Even where the coal has been completely dewatered, insufficient oxygen is present for oxidation to be carried forward" (Lyman and Volkmer 2001). After coal gas extraction is complete, CBNG wells leave no underground voids susceptible to subsidence and associated coal ignition as seen in abandoned underground mines, which are susceptible to spontaneous ignition.

Subsidence

Ground subsidence resulting from withdrawal of CBNG-related water has been cited as a potential hazard of CBNG development. A number of documented cases have demonstrated the association of withdrawal of underground fluids and subsidence. The best examples include specific sites in the San Joaquin Valley in California, Las Vegas, New Orleans, Houston, and Mexico City. Subsidence in these areas is chiefly related to removal of water for human consumption or agricultural use. Removal of water from underlying saturated, chiefly unconsolidated, and porous sand and gravel aquifers lowers the water table and causes the previously saturated zones to compress, causing subsidence. Saturated unconsolidated sands and gravels and porous clays can compress significantly; in some cases, as much as 29 feet of subsidence has resulted.

The subsurface geologic conditions in the ARPA, however, differ significantly from these areas. The bedrock underlying the area is compacted and consolidated, and porosity is much lower. In comparison, unconsolidated sands and gravels and clays have porosity values as high as 50 and 88 percent, respectively (Poland 1984); whereas, values for consolidated clay (shale) and sand (sandstone) in the ARPA have porosity values as high as 10 and 30 percent, respectively (Freeze and Cherry 1979). Ground subsidence was modeled for CBNG production for the Wyodak coal in the Powder River Basin, near Gillette. Calculations from this model indicate that subsidence of less than half of an inch (1.27 centimeter) can be expected (Case et al. 2002). However, in the ARPA, CBNG would be withdrawn from strata that occur much deeper in the subsurface than those in the Powder River Basin. Because of that increased depth, any subsidence would be attenuated and is therefore not considered significant.

Mass Movement

Quaternary landslides occur primarily along the eastern edge of the project area, including from north to south along the west side of Separation Peak, Atlantic Rim, Bridger Pass, Sand Hills, Cow Creek Butte, and along the east side of Muddy Mountain (Case and Larsen 1991). One of the largest of the mapped landslides occupies about 20 miles² of area in sections 25 and 26, T14N:R90W (Weitz and Love 1952). The displaced material includes rocks derived from the Miocene Browns Park Formation and underlying Lewis Shale and emplaced by movement from the southeast to the northwest. Similarly, most of the landslides mapped along the eastern boundary of the area are developed in the Browns Park Formation, which contains tuffaceous and bentonitic clay beds rich in montmorillonite that are susceptible to swelling and mass movement when water-saturated, especially where exposed on steep or undercut slopes.

Additional landslide debris is mapped around Doty Mountain (T17N:R91W), Wildhorse Butte (T14N:R91W), and Muddy Mountain (T13N:R89W). Mass movement in these areas is associated with steep slopes developed in the Lance Formation, Wasatch Formation, and Lewis Formation, respectively, all of which contain clay-rich shale beds that are also susceptible to mass movement when water-saturated, especially where exposed on steep or undercut slopes.

3.1.2 Mineral Resources

Mineral resources within the ARPA region include locatable mineral deposits of basal and precious metals, bentonite, gypsum, limestone, uranium, zeolite, gravel, and clinker, as well as leasable minerals, such as oil, gas, coal, and CBNG.

3.1.2.1 Locatable Minerals

No economic deposits of locatable minerals are known to occur within the ARPA. Economic deposits of Quaternary windblown sand are developed 20–30 miles north-northeast of the town of Baggs, Wyoming, just east of the project area (Harris 1996). These are continuations of dune deposits that occur in the east central parts of the ARPA, but they are probably not thick enough to be economic.

Uranium-bearing prospects occur in the Browns Park Formation in (1) the Ketchum Buttes District adjacent to the ARPA in the NW1/4, T15N:R89W, (2) the Miller Hill Prospect about 10 miles south-southwest of Rawlins in T18N:R88-89W, and (3) the Poison Basin Uranium District about 10 miles west of the town of Baggs (Harris et al. 1985). Economically significant shows of uranium occur in coals of the main body of the Wasatch Formation north of Wamsutter, Wyoming (Masursky 1962), and in the region around the towns of Creston and Latham (Harris et al. 1985, Harris and King 1993), about 15 miles west of the north edge of the ARPA. Uranium is also known to exist in arkoses of the Battle Spring Formation of the central Great Divide Basin (Pipiringos 1961), which is in part equivalent to the upper part of the Wasatch Formation exposed just west of the project boundary.

Gravel, preserved as Quaternary terrace and channel remnants, and clinker associated with burnt coal seams occur at several locations within the ARPA. Some of these have been locally exploited and developed as gravel (W/2 Section 26, T14N:R91W and W/2, SW/4 Section 2, T14N: R90W) and clinker ("scoria") pits (W/2 Section 6, T15N:R91W, and NE/4 Section 1, T15N: R92W). Other gravels (center of NW/4 Section 28, T16N:R92W and N/2 Section 22, T17N:R92W) and clinker (N/2 Section 5, T17N:R91W and SE/4, SE/4, SE/4 Section 35, T18N:R91W) have not been exploited.

3.1.2.2 Leasable Minerals

Coal and CBNG occur in Tertiary and Cretaceous age geologic formations; oil and gas occur in geologic formations of Cretaceous, Jurassic, Triassic, and Pennsylvanian ages underlying the project area. All federal minerals within the ARPA have been leased for oil and gas development consistent with the RMP.

Coal and Coal bed Natural Gas

Fort Union Formation. The Fort Union Formation of south and southwestern Wyoming constitutes an enormous, largely untapped reserve of coal. Coals occur throughout the formation, but are thickest and most continuous in its lower part (the lower coal bearing unit) (Smith et al. 1972, Sanders 1974 and 1975, Beaumont 1979, Edson 1979, Hettinger and Brown 1979, Honey and Roberts 1989, Honey and Hettinger 1989, Honey 1990, Jones 1991, Hettinger et al. 1991).

Within and adjacent to the ARPA, coal seams of the Fort Union comprise the Red Rim and China Butte coals. These coals are best developed from the southernmost parts of T21N:R90W (a few miles south of Interstate 80 [I-80]) southward to T15N:R92W. From there southward to T13N:R91W, the coals become discontinuous and spotty in distribution. Both the Red Rim and China Butte coals have high known mineral deposit area (KMDA) values (greater than \$1 million based on 1981 prices). Together they include about 26,234 leasable acres.

Studies of the Fort Union Formation coals in the ARPA and adjacent areas have been conducted by Sanders (1974 and 1975), Edson (1979), Honey and Hettinger (1989), Honey and

Roberts (1989), and Honey (1990). As many as 10 coals seams have been mapped in the subsurface with individual seams averaging 10 to 20 feet thick, but thickening to as much as 40 feet. Net coal thickness increases in the subsurface southward toward the Baggs area where it may reach a maximum of about 75 feet. Thicker Fort Union coals have been interpreted to have accumulated in floodplains above and on the flanks of major Paleocene age, south-to-north-oriented river systems. Thinner coal seams accumulated away from these main trunk streams.

The Fort Union Formation is a primary CBNG target in the southeastern Greater Green River Basin, but the formation outcrops at the surface only in the western-most part of the project area, so few if any of the coalbeds that dip westward are buried deep enough to be candidates for development. Deeper buried coalbeds east and south of the area have ash-free gas contents generally less than 100 standard cubic feet (scf)/ton (but ranging from 9 to 561 scf/ton). In the western and southwestern parts of Carbon County, Wyoming, underlying the project area, Scott et al. (1994) estimated coal gas reserves to be less than 2 billion cubic feet per square-mile (bcf/mile²) near the eastern margins of its subcrop to 6 to 8 bcf/mile² in deeper buried areas north and west of Baggs, Wyoming. These values may be enhanced by migration of gasses into the area from deeper parts of the basin. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, Fort Union coals rank as subbituminous high volatile C bituminous and high volatile B bituminous.

Lance Formation. Coals occur discontinuously in outcrops in the Lance Formation from I-80 south to about T15N. Averaging about five feet in thickness, but ranging from a few inches to 22 feet thick, coals are thicker, more abundant, and laterally extensive in the lower part of the formation. The coals have limited lateral extent and usually cannot be traced more than a few hundred to several thousand feet. Lance Formation coalbeds are minor CBNG targets (Scott et al. 1994).

Mesaverde Group. Coals occur in outcrops in the Mesaverde Group in several places along the western edge of the Sierra Madre. These are best developed high in the Mesaverde Group near its contact with the overlying Lewis Shale in exposures along the eastern edge of the ARPA (Atlantic Rim and Green River Coal Fields) and in T15-16N:R90-91W (an unnamed coal field). These fields have a KMDA value (less than \$1 million based on 1981 prices) and include about 230,400 leasable acres. Coals are also developed sporadically lower in the Mesaverde Group (Allen Ridge Sandstone), but these coals are thin and discontinuous, and areas containing them are rated as having a low KMDA value. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, the Mesaverde coals underlying the ARPA rank as high volatile C bituminous, high volatile B bituminous, and high volatile A bituminous.

Coals in the Ericson Sandstone (aka, Pine Ridge Sandstone or Williams Fork Formation) include the thickest and most extensive coals of the Upper Cretaceous in the Greater Green River Basin and are the basin's prime CBNG targets. The maximum net coal thickness of about 220 feet, contained in 40 individual coalbeds, occurs near Craig, Colorado. The coalbeds thin in a westerly and northerly direction, so that in the ARPA net coal thicknesses range from 40 to 90 feet (12 to 18 meters). These coals are interpreted to have accumulated in coastal plain environments and fluvial-dominated, wave-modified deltas along a southwest-northeast-oriented strand (beach) line that faced southeastward into the Cretaceous epicontinental seaway. Three depositional coal cycles are represented that accumulated in response to progradation as a result of drops in sea level or changes in delta location, or both. The thickest coals in these cycles overlie shoreline sandstones with thinner and less continuous coals developed between deltaic distributary channel sandstones.

Gas content values for coals developed in the Ericson Sandstone range from less than 1 to more than 540 scf/ton, but are generally less than 200 scf/ton. Samples from the Sand Wash Basin indicate a gradual increase in gas content with increasing burial, but coal rank does not increase significantly with depth. Gas contents of samples taken shallower than 1,000 feet are less than 20 scf/ton suggesting that coal bed gases may have migrated out of the system because either confining pressures were low, the overlying seals were absent, or both. Analysis of 36 coal samples from six wells provided a gas dryness ratio ranging from 0.79 to 1.0 with an average of 0.95; carbon dioxide content of less than 1 to more than 25 mole percent, with an average of 6.7 mole percent; and a nitrogen content of less than 1 to 20 mole percent, with an average of 4 mole percent. Coals having high carbon dioxide content are characterized by high C1-C1-5 values.

Based on gas content values, Scott et al. (1994) estimated coal gas reserves in the western and southwestern parts of Carbon County, Wyoming, underlying the ARPA, to be less than or equal to 10 bcf/mile² near the eastern margins of its subcrop and 8 to 40 bcf/mile² in the extreme southwestern corner of the county.

Coals in the Rock Springs Formation (Allen Ridge Sandstone or Iles Formation) are thinner and not as well developed as those in the Pine Ridge, which is considered a minor coal-bearing unit and CBNG target. A maximum net coal thickness of 32 feet occurs in the easternmost part of the Great Divide Basin, but most other places it is typically less than 15 feet. These coals are interpreted to have accumulated in a variety of swampy environments above shoreline sandstones and in floodplains adjacent to delta river channels.

Based on samples from wells primarily in the Rock Springs Uplift, gas content values in the Rock Springs Formation range from 0 to more than 650 scf/ton. No estimates of total coal gas reserves are available for this unit.

Oil and Gas

The ARPA and adjacent areas to the west have produced significant quantities of oil and natural gas. Production is chiefly from Cretaceous geologic units including the Mesaverde Group, Steele Shale, Niobrara Shale, Frontier Formation, Muddy Sandstone, and Cloverly Formation. In addition, Jurassic rocks of the Morrison Formation, Triassic rocks of the Chugwater Formation, and Pennsylvanian rocks of the Tensleep Sandstone have proved productive. Oil and gas fields of interest (The Oil and Gas Fields Symposium committee 1957, 1979, and 1992; Gregory and DeBruin 1991; DeBruin and Boyd 1991; DeBruin 1993 and 1996; Cronoble 1969; and Kaiser et al. 1994) include the following:

- The Baldy Butte (T17N:R92W),
- Browning (T14N:R91W),
- Browns Hill (T16N:R90-91W),
- Cherokee Creek (T15N:R91W),
- Cow Creek (T16N:R92W),
- Deep Creek (T16N:R90-91W),
- Deep Gulch (T16N:R91W),
- Dixon (T12-13N:R90W),
- Espy (T19N:R89W),
- Sierra Madre (T13N:R89-90W), and
- Sugar Creek (T19N:R90W).

CHAPTER 3. AFFECTED ENVIRONMENT

Oil and gas are produced from combined stratigraphic and faulted structural (anticlinal) traps.

3.1.3 Paleontologic Resources

Known paleontologic resources within sedimentary deposits in the project area record the history of animal and plant life in Wyoming during the early part of the Cenozoic Era (Paleocene and Eocene Epochs) and the latest part of the Mesozoic (Cretaceous Period) Era. Potential fossil resources could extend this record into the late Cretaceous Period and middle Cenozoic Era (Miocene).

As described above, mapping documents eight geologic deposits exposed at the surface in the project area. These include, from youngest to oldest: (1) unnamed deposits of Quaternary (Holocene to Pleistocene) age, (2) Browns Park Formation of Miocene age, (3) Wasatch Formation of early Eocene age, (4) Fort Union Formation of Paleocene age, (5) Lance Formation of Latest Cretaceous age, (6) Fox Hills Sandstone of latest Cretaceous age, (7) Lewis Shale of Latest Cretaceous age, and (8) Mesaverde Group of Late Cretaceous age.

With the exception of the Holocene deposits that are probably too young to contain fossils, all sedimentary rock units exposed in the project area are known to produce or have the potential to produce scientifically significant vertebrate fossil resources. Scientifically significant fossil vertebrates have been recovered from the following formations within the ARPA or immediately adjacent areas:

- Wasatch (Morris 1954, Honey 1988; Roehler 1972, 1991a, 1991b, 1992a, 1992b, 1992c, and 1993, Roehler et al. 1988),
- Seventeen fossil vertebrate localities from the Fort Union (Rigby 1980, Winterfeld 1982), and
- Fifteen fossil vertebrate localities from the Lance Formations (Dorf 1942, Estes 1964, Clemens 1966, Clemens et al. 1979, Breithaupt 1982 and 1985, Weishample 1992, Archibald 1993, Lillegraven 2002, Honey 2003).

The Lance Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T18N:R20W), Doty Mountain (T17N:R91-92W), Peach Orchard Flat (T15N:R91W), and Blue Gap (T15N:R91W) 7.5 minute Quadrangles. The Fort Union Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T19N:R91W), Duck Lake (T16-17N:R91-91W), Mexican Flats (T16N:R92W), and Blue Gap (T15-16N:R91-92W) 7.5 minute Quadrangles. Localities from both the Lance and Fort Union Formations produce a wide variety of fossil vertebrate remains including those of mammals, reptiles, amphibians, and fish. Of great importance is the occurrence within the Fort Union Formation of some of the oldest known Paleocene age fossil vertebrates in the world, which are considered to be of Puercan age and are very rare (Honey 2003).

Vertebrate fossils of scientific significance have also been found in other areas of Wyoming and Colorado, but not within the ARPA. These fossils were found in deposits of the Browns Park Formation (McGrew 1951 and 1976, Bradley 1964, Montagne 1991) and Mesaverde Group (Breithaupt 1985, Case 1987, Clemens and Lillegraven 1986, Lillegraven and McKenna 1986). Vertebrate fossils of limited significance have been identified in the Fox Hills and Lewis Shale exposed on the Rocks Springs Uplift (Winterfeld 1979, Breithaupt 1985). Information on the

geologic deposits exposed in the project area and the BLM Paleontologic Condition they satisfy are summarized in table 3-2.

3.2 Climate and Air Quality

3.2.1 Climate

The ARPA is located in a semiarid (dry and cold), mid-continental climate regime. The area is typified by dry, windy conditions with limited rainfall and long, cold winters. The nearest meteorological measurements were collected at Baggs, Wyoming (1979–2000), approximately 3 miles southwest of the project area at an elevation of 6,240 feet amsl (WRCC 2003). Because of the wide variation in elevation and topography within the study area, site-specific climatic conditions vary considerably.

The annual average total precipitation at Baggs, Wyoming is 10.7 inches, ranging from 18.5 inches (1983) to 4.6 inches (1989). Precipitation is evenly distributed throughout the year with minor peaks in May, July, and October. An average of 38.8 inches of snow falls during the year (annual high 104.0 inches in 1983), with the snowiest months in December and January. Table 3-3 shows the mean monthly temperature ranges and total precipitation amounts.

The Baggs, Wyoming, region has cool temperatures with average daily temperatures ranging between a low of 3 degrees Fahrenheit (°F) and a high of 33°F in mid winter and between 56°F and 75°F in mid summer. Extreme temperatures have ranged from –50°F to 100°F (both occurring in 1984). The frost-free period (at 32°F) generally occurs from mid-May to mid-September.

Table 3-3. Mean Monthly Temperature Ranges and Total Precipitation Amounts.

Month	Average Temperature Range (°F)	Total Precipitation (inches)
January	5–33	0.56
February	9–36	0.43
March	20–47	0.44
April	28–59	0.82
May	34–68	1.52
June	41–79	0.89
July	48–86	1.33
August	46–84	0.99
September	38–74	1.14
October	27–61	1.39
November	16–43	0.66
December	7–34	0.54
ANNUAL	42.6 (mean)	10.71 (mean)

Source: WRCC 2003

The ARPA is subject to strong and gusty winds, reflecting channeling and mountain valley flows due to complex terrain. During the winter months, strong winds are often accompanied by snow producing blizzard conditions and drifting snow. The closest comprehensive wind measurements are collected at the Rawlins, Wyoming airport nearly 9 miles north-northeast of the ARPA. However, hourly wind data measurements for December 1994 through November 1995 were collected near Baggs, Wyoming, during the Mount Zirkel Wilderness Area Visibility Study (CIRA 2003). Due to the proximity to the project area, these data (rather than

CHAPTER 3. AFFECTED ENVIRONMENT

the more distant Rawlins wind data) were used to describe the wind flow patterns in the region. Figure 3-1 shows the relative frequency of winds, with radial distributions by speed class, indicating the direction of the wind source. Table 3-4 provides the wind direction distribution in a tabular format. From this information, it is evident that the winds originate from the south to southwest nearly 37 percent of the time. The annual mean wind speed is nearly 10 miles per hour (mph).

Table 3-4. Wind Direction Frequency Distribution for Baggs, Wyoming.

Wind Direction	Percent of Occurrence
N	5.2
NNE	3.8
NE	2.7
ENE	3.8
E	4.8
ESE	8.9
SE	6.9
SSE	7.6
S	13.8
SSW	13.4
SW	10.0
WSW	5.1
W	4.4
WNW	4.0
NW	2.6
NNW	3.1

Source: South Baggs meteorological data collected December 1994 - November 1995.

The frequency and strength of the winds greatly affect the dispersion and transport of air pollutants. Because of the strong winds in the project area, the potential for atmospheric dispersion is relatively high. Nighttime cooling would enhance stable air, inhibiting air pollutant mixing and transport. Dispersion conditions would be the greatest to the north and along the ridge and mountain tops.

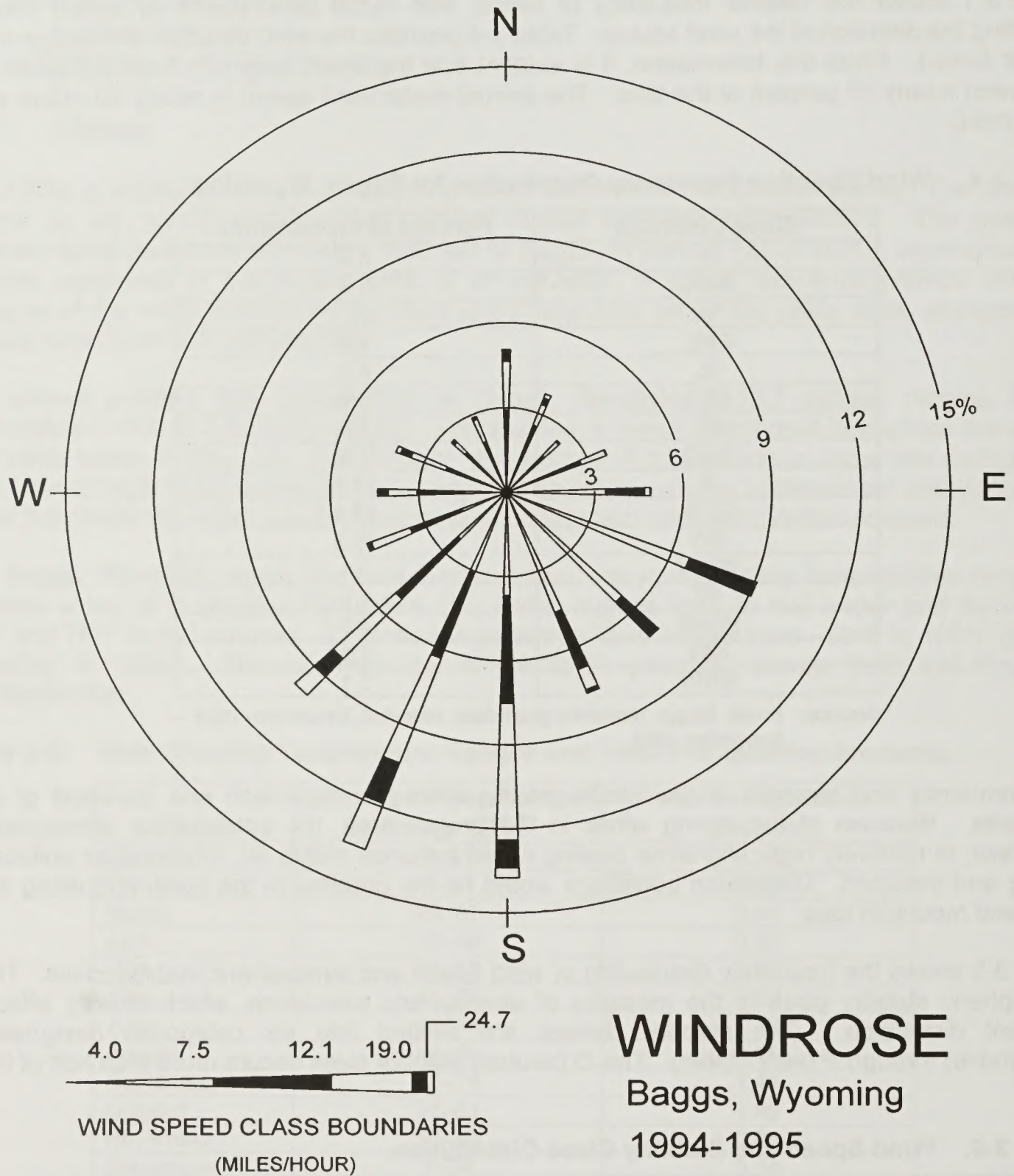
Table 3-5 shows the frequency distribution of wind speed and atmospheric stability class. The atmospheric stability class is the measure of atmospheric turbulence, which directly affects pollutant dispersion. The stability classes are divided into six categories designated A (unstable) through F (very stable). The D (neutral) stability class occurs more than half of the time.

Table 3-5. Wind Speed and Stability Class Distribution.

Wind Speed (miles/hour)	Percent of Occurrence	Stability Class	Percent of Occurrence
0-4.0	6.4	A (unstable)	6.0
4.0-7.5	33.0	B	8.2
7.5-12.1	29.8	C	14.8
12.1-19.0	21.7	D (neutral)	56.6
19.0-24.7	5.4	E	9.9
Greater than 24.7	3.7	F (very stable)	4.5

Source: South Baggs meteorological data collected December 1994–November 1995.

Figure 3-1. Wind Rose for the Atlantic Rim Natural Gas Project Area.



NOTES:
DIAGRAM OF THE FREQUENCY OF
OCCURRENCE OF EACH WIND DIRECTION.
WIND DIRECTION IS THE DIRECTION
FROM WHICH THE WIND IS BLOWING.
EXAMPLE - WIND IS BLOWING FROM THE
NORTH 5.1 PERCENT OF THE TIME.

Source: South Baggs meteorological data collected December 1994–November 1995.

CHAPTER 3. AFFECTED ENVIRONMENT

3.2.2 Air Quality

The Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS) are health-based criteria for the maximum acceptable concentrations of air pollutants at all locations to which the public has access. Although specific air quality monitoring has not been conducted within the project area, regional air quality monitoring has been conducted within the cumulative study area (See the Air Quality Technical Support Document, appendix F, map 1.2 and map M-8 of this EIS). Air pollutants measured in the region for which ambient air quality standards exist include carbon monoxide, nitrogen dioxide, ozone, particulate matter less than 10 microns in effective diameter (PM₁₀), particulate matter less than 2.5 microns in effective diameter (PM_{2.5}), and sulfur dioxide. Background pollutant concentrations for these pollutants are compared to the WAAQS and NAAQS in table 3-6.

Table 3-6. Air Pollutant Background Concentrations, Wyoming and National Ambient Air Quality Standards and Prevention of Significant Deterioration Increments.

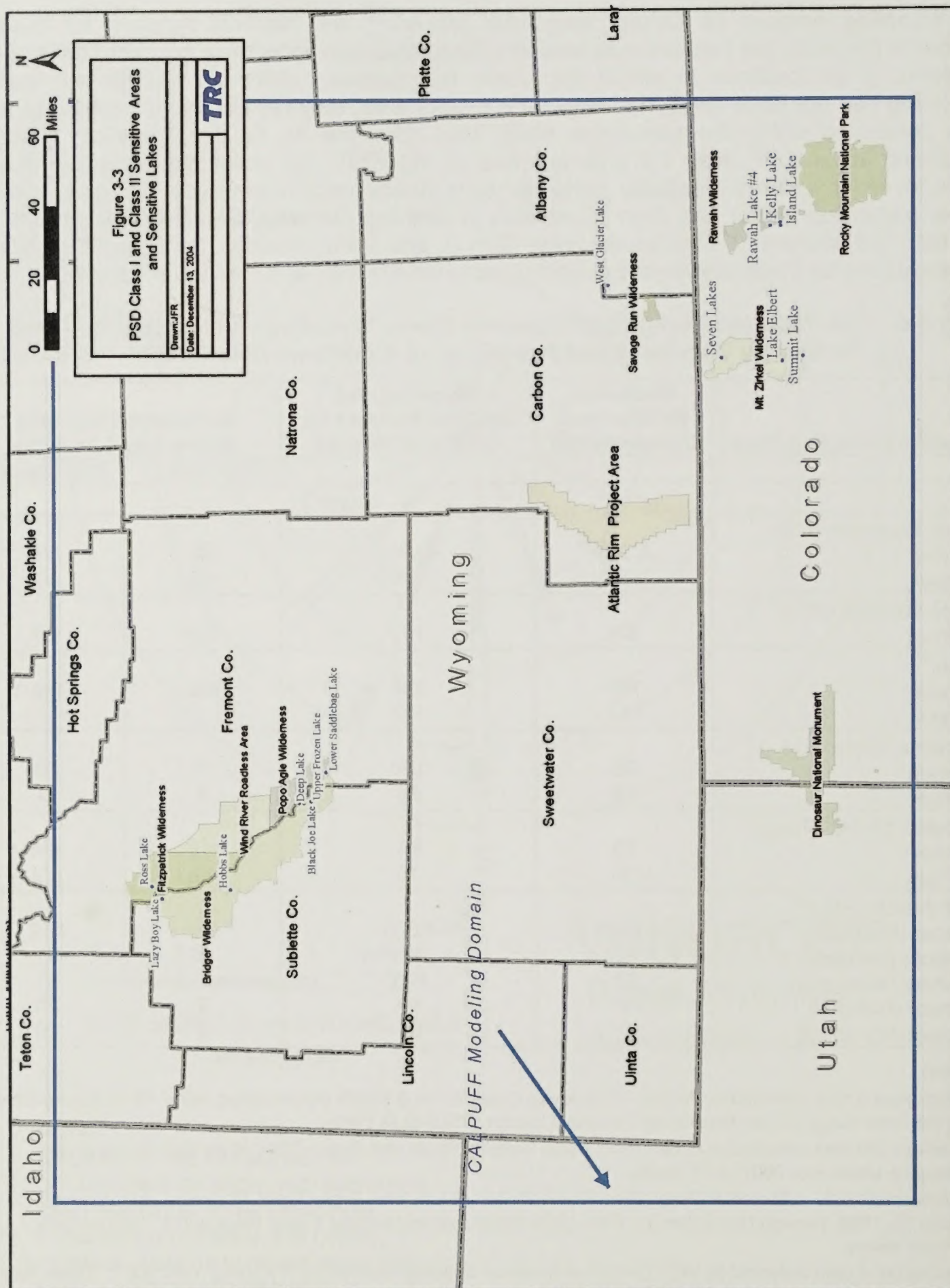
Pollutant/Averaging Time	Measured Background Concentration	Wyoming and National Ambient Air Quality Standards	Incremental Increase Above Legal Baseline	
			PSD Class I	PSD Class II
			(µg/m ³)	
Carbon Monoxide (CO) ¹				
1-hour	3,336	40,000	n/a	n/a
8-hour	1,381	10,000	n/a	n/a
Nitrogen dioxide (NO ₂) ²				
Annual	3.4	100	2.5	25
Ozone ³				
1-hour	169	235	n/a	n/a
8-hour	147	157		
Particulate Matter (PM ₁₀) ⁴				
24-hour	33	150	8	30
Annual	16	50	4	17
Particulate Matter (PM _{2.5}) ⁴				
24-hour	13	65	n/a	n/a
Annual	6	15	n/a	n/a
Sulfur dioxide (SO ₂) ⁵				
3-hour (National)	132	1,300	25	512
24-hour (National)	43	365	5	91
24-hour (Wyoming)	43	260	5	91
Annual (National)	9	80	2	20
Annual (Wyoming)	9	60	2	20

Notes:

- ¹ Background data collected by Amoco at Ryckman Creek for an 8-month period during 1978–1979, summarized in the Riley Ridge EIS Air Resources Technical Report (USDI-BLM 1983).
- ² Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January–December 2001 (ARS 2002).
- ³ Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002) (second highest 1-hour value and 4th highest daily 8-hour value).
- ⁴ Background data collected by WDEQ-AQD at Emerson Building, Cheyenne, Wyoming, Year 2001. These data have been determined by WDEQ-AQD to be the most representative collocated PM₁₀ and PM_{2.5} data available (second highest 24-hour values).
- ⁵ Background data collected at LaBarge Study Area for the Northwest Pipeline Craven Creek Site 1982–1983.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-8. PSD Class I and Class II Sensitive Areas and Sensitive Lakes.



CHAPTER 3. AFFECTED ENVIRONMENT

As shown in table 3-6, regional background values are below established standards, and all areas within the cumulative study area are designated as attainment for all criteria pollutants. Background air quality concentrations are combined with modeled project-related air quality impacts of the same averaging time periods, and the total predicted impacts are compared to applicable air quality standards. EPA published a final rule on August 3, 2005 revoking the 1-hour ozone standard for all areas of Wyoming effective June 15, 2005. The WDEQ-AQD then completed the process of removing the 1-hour standard from Wyoming Air Quality Standards & Regulations effective January 30, 2006. As a result, there is no federal or state 1-hour ozone standard that applies to Wyoming.

EPA published final revisions to the National Ambient Air Quality Standards for particulate matter in the Federal Register on October 17, 2006 which take effect on December 18, 2006. The revision strengthens the 24-hour PM_{2.5} standard from 65 to 35 ug/m³ and revokes the annual PM₁₀ standard of 50 ug/m³. EPA retained the existing annual PM_{2.5} standard of 15 ug/m³ and the 24-hour PM₁₀ standard of 150 ug/m³. After the final rule becomes effective, the State of Wyoming will enter into rulemaking to revise the Wyoming Ambient Air Quality Standards.

Federal air quality regulations adopted and enforced by the Wyoming Department of Environmental Quality-Air Quality Division (WDEQ-AQD) limit incremental emissions increases to specific levels defined by the classification of air quality in an area. The Prevention of Significant Deterioration (PSD) Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. The incremental increase depends upon the area's classification. Four PSD Class I areas are identified as sensitive areas within the cumulative study area: the Bridger, Fitzpatrick, Mount Zirkel, and Rawah Wilderness Areas (map M-8). Strict limitations on the additional amount of air pollution allowed from major emitting facilities in PSD Class I areas are applied. These limitations are quantified as Class I PSD Increments, which are compared to impacts from cumulative regional sources, and Proposed Class I PSD Significance Levels, which are compared to impacts from individual emission sources to determine their singular significance. The remainder of the cumulative impact study area is classified PSD Class II, where similar but less stringent incremental air quality limits apply. The Popo Agie and Savage Run Wilderness Areas, Dinosaur National Monument, and the Wind River Roadless Area are PSD Class II areas, which have been identified as sensitive areas within the cumulative study area. PSD Class I and Class II Areas are shown on map M-8. Regional background pollutant concentrations, as well as NAAQS, WAAQS, and PSD Classes I and II Increments, are presented in table 3-6.

All NEPA analysis comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis. The determination of PSD increment consumption is an air quality regulatory agency responsibility. Such an analysis would be conducted as part of the New Source Review process for a major source, as would an evaluation of potential impacts to Air Quality Related Values (AQRV) such as visibility, aquatic ecosystems, flora, and fauna performed under the direction of WDEQ-AQD in consultation with federal land managers or would be conducted to determine minor source increment consumption.

There are two types of visibility impairments caused by emission sources, plume impairment and regional haze. Plume impairment occurs when a section of the atmosphere becomes visible due to the contrast or color difference between a discrete pollutant plume and a viewed background such as a landscape feature. Regional haze occurs when pollutants from more diffuse emission sources become well mixed in the atmosphere causing a general alteration in

CHAPTER 3. AFFECTED ENVIRONMENT

the appearance of landscape features, changing the color or contrast between the landscape features or causing features of a view to disappear. Plume impairment calculations, which consider contrast and color difference, are generally performed when an emissions source is within 50 kilometers of a view; whereas, impacts of regional haze or visibility impairment are considered at 50 kilometers and beyond.

Visibility impairment is often referred to in terms of either atmospheric light extinction coefficient or visual range. Atmospheric light extinction is the result of light scattering and absorption by gases and particles in the atmosphere. Visibility impairment is measured in terms of change in light extinction or change in deciview (dv). A dv change of 1 to 2 (equivalent to a 10 to 20 percent change in extinction) represents a small but perceptible change in visibility. Visual range, referred to as standard visual range (SVR), is the farthest distance at which an observer can just see a black object viewed against the horizon sky. The higher the SVR, the better the visibility. Visibility within the cumulative study area is considered very good with an average SVR of over 150 kilometers (Malm 2000). However, the potential for visibility impairment to current conditions at the PSD Class I and Class II areas identified within the cumulative study area has been identified as a concern.

In 1985, the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring program was initiated to establish current visibility conditions, track changes, establish long-term trends in visibility, and to determine the causal mechanisms of visibility impairment in the national parks and wilderness areas. IMPROVE is a cooperative measurement effort composed of representatives from the United States Environmental Protection Agency (EPA), National Park Service (NPS), United States Department of Agriculture (USDA) Forest Service, BLM, U.S. Fish and Wildlife Service (USFWS), and state agencies. The IMPROVE network began with 20 monitoring sites in 1987 and now includes over 140 sites representing Class I parks and wilderness areas across the nation.

Within the cumulative study area, there are currently four IMPROVE visibility monitoring sites: the Bridger Wilderness Area and Brooklyn Lake sites in Wyoming and the Mount Zirkel Wilderness Area and Rocky Mountain National Park sites in Colorado. Table 3-7 provides 2001 baseline visibility conditions monitored at these four sites (CIRA 2003).

Table 3-7. 2001 Standard Visual Range Data.

Site	Standard Visual Range (km)	
	Average Condition	20 th Percent Cleanest Days
Bridger Wilderness Area	181	272
Brooklyn Lake	184	283
Mount Zirkel Wilderness Area	175	249
Rocky Mountain National Park	154	275

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems. Atmospheric deposition is reported as the mass of material deposited on an area per year (kilograms per hectare per year [kg/ha-yr]). Air pollutants are deposited by wet deposition (precipitation) and dry deposition (gravitational settling of pollutants). Background wet and dry atmospheric acid deposition impacts have been monitored at the National Acid Deposition Program (NADP) National Trends Network (NTN) and Clean Air Status and Trends Network (CASTNET) stations near Pinedale and Centennial/Brooklyn Lake, Wyoming. Total deposition (wet and dry) reported as total sulfur

CHAPTER 3. AFFECTED ENVIRONMENT

and total nitrogen deposition for Pinedale in 2003 and Centennial/Brooklyn Lake in 2002 are provided in table 3-8.

Table 3-8. 2001 Measured Acid Deposition Data.

Site Location	Nitrogen Deposition	Sulfur Deposition
	(kg/ha-yr)	
Pinedale (2003)	1.4	0.65
Centennial/Brooklyn Lake (2002)	2.7	0.84

Total deposition levels of concern (LOCs) have been estimated for several areas including the Bridger Wilderness Area (USDA-FS 1989). The *red line* LOC is defined as the total deposition that the area can tolerate; the *green line* LOC is defined as the acceptable level of total deposition. Cumulative impacts plus background are compared to these LOCs. The Bridger Wilderness nitrogen deposition red line LOC is 10 kg/ha-yr and nitrogen deposition green line LOC is 3–5 kg/ha-yr. The Bridger Wilderness sulfur deposition red line LOC is 20 kg/ha-yr and sulfur deposition green line is 5 kg/ha-yr.

Site-specific lake chemistry background data (pH, acid neutralizing capacity, elemental concentrations, etc.) have been collected by the USGS (Water Quality Division) in several high mountain lakes in the nearby Wilderness Areas. Lakes for which background data were collected are shown on map M-8). Lake acidification is measured in terms of change in acid neutralizing capacity (ANC), which is the lake's buffering capacity to resist acidification from atmospheric deposition of acid compounds such as sulfates and nitrates. Measured baseline ANC data for sensitive lakes within the cumulative study area are provided in table 3-9.

Table 3-9. Background ANC Values for Acid-Sensitive Lakes.

Wilderness Area	Lake	Latitude (Deg-Min-Sec)	Longitude (Deg/Min-Sec)	10 th Percentile Lowest ANC Value ¹ (µeq/L)	Number of Samples	Monitoring Period
Bridger	Black Joe	42°44'22"	109°10'16"	67.0	61	1984–2003
Bridger	Deep	42°43'10"	109°10'15"	59.9	58	1984–2003
Bridger	Hobbs	43°02'08"	109°40'20"	69.9	65	1984–2003
Bridger	Lazy Boy	43°19'57"	109°43'47"	18.8	1	1997
Bridger	Upper Frozen	42°41'13"	109°09'39"	5.0	6	1997–2003
Fitzpatrick	Ross Lake	43°22'41"	109°39'30"	53.5	44	1988–2003
GLEES	West Glacier Lake	41°22'38"	106°15'31"	35.2	14	1988–1996
Mount Zirkel	Lake Elbert	40°38'3"	106°42'25"	51.9	55	1985–2003
Mount Zirkel	Seven Lakes	40°53'45"	106°40'55"	36.2	55	1985–2003
Mount Zirkel	Summit Lake	40°32'43"	106°40'55"	47.3	95	1985–2003

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-9. Background ANC Values for Acid-Sensitive Lakes.

Wilderness Area	Lake	Latitude (Deg-Min-Sec)	Longitude (Deg/Min-Sec)	10 th Percentile Lowest ANC Value ¹ (µeq/L)	Number of Samples	Monitoring Period
Popo Agie	Lower Saddlebag	42°37'24"	108°59'38"	55.5	43	1989–2003
Rawah	Island Lake	40°37'38"	105°56'26"	68.7	15	1996–2002
Rawah	Kelly Lake	40°37'32"	105°57'34"	181.1	13	1995–2002
Rawah	Rawah #4 Lake	40°40'16"	105°57'28"	41.2	13	1996–2002

Note:

¹ 10th Percentile Lowest acid-neutralizing capacity (ANC) values reported
GLEES – Glacier Lakes Ecosystem Experiment Site

Lakes with ANC values ranging from 25 to 100 microequivalents per liter (µeq/L) are considered to be sensitive to atmospheric deposition, lakes with ANC values ranging from 10 to 25 µeq/L are considered very sensitive, and lakes with ANC values less than 10 µeq/L are considered extremely sensitive.

The United States Department of Agriculture Forest Service (USDA-FS) has identified specific AQRV level of acceptable change (LAC) values, which are used to evaluate potential air quality impacts from deposition within their wilderness areas (USDA-FS 2000). The USDA-FS has identified a LAC of no greater than 1 µeq/L change in ANC (from human causes) for lakes with existing ANC levels less than 25 µeq/L. A limit of 10 percent change in ANC reduction was adopted for lakes with existing ANC greater than 25 µeq/L.

3.3 Soils

Vegetation type, growth form, composition, distribution, and density in the ARPA are principally governed by the biological, chemical, and physical properties of the parent soil and precipitation regime. The complex relationship of these two essential natural resources ultimately controls habitat quantity and quality for the fauna and flora of Wyoming.

Parent materials in the ARPA include:

- The marine sandstones and shales of the Lewis Formation (Upper Cretaceous);
- The largely fluvial conglomerates, sandstones, mudstones, shales, and coals of the Lance Formation (Upper Cretaceous) and Fort Union Formation (Paleocene);
- The fluvial sandstones and variegated mudstones of the Wasatch Formation (Eocene); and
- The conglomerates, sandstones, and volcanoclastic mudstones of the Browns Park Formation (Miocene).

CHAPTER 3. AFFECTED ENVIRONMENT

Slopewash debris and alluvium derived from those units also constitute parent materials for colluvial and alluvial soils. A large area known as the Sand Hills (series of Holocene-age sand dunes) occurs in the east central part of the ARPA.

The ARPA is typical of a desert intermontane basin with physiography dominated by (1) hogbacks and strike valleys, (2) flat-topped stripped bedrock surfaces (strath terraces), (3) pebble/gravel/cobble stream terraces, (4) alluvial fan deposits, and (5) alluvium along the principal drainages.

Surface elevations within the ARPA range from 8,294 feet amsl (2,529 meters) in Section 13, T18N:R90W, to about 6,500 feet amsl (1,982 meters). Several Mesaverde Group hogbacks above Separation and Jep Canyon reach elevations exceeding 8,000 feet amsl (2,438 meters). Prominent landmarks include Cow Creek Butte (7,929 amsl feet/2,417 meters) developed in the Browns Park Formation (NE1/4 Section 15, T16N:R90W) and Muddy Mountain (7,904 feet amsl /2,409 meters) developed on a Lance Formation hogback (NE1/4 Section 8, T13N:R90W). The lowest point (6,420 feet amsl/1,957 meters) occurs on Peach Orchard Flat in the floodplain alluvium of Muddy Creek (Section 31, T15N:R91W).

Slopes within the project area are generally level to undulating (0 to 10 percent), broken by areas of steeper (10 to 40 percent) and very steep slope to vertical faces (rock outcrops). Maximum slope over a 3-mile intersect is about 7-percent grade (1,100 feet rise in 15,840 ground feet in the S1/2 T18N:R90W) and the minimum slope nears a 0-percent grade in the NE ¼ T16N:R92W and at a few other sites.

3.3.1 Project Area Soils

Texas Resource Consultants (1981) and Wells et al. (1981) surveyed and described the dominant soil series, associations, and complexes encompassed within the project area at a third-order level of detail. Each of these soil survey efforts was conducted for the BLM in cooperation with the National Resource Conservation Service (NRCS), then called the Soil Conservation Service (SCS). Interpretation ratings were developed for each map unit based upon the *Soil 5* filled out for the soil series, which were based upon standards and procedures of the National Soils Handbook, the SCS Guide for Interpreting Engineering Uses of Soils (USDA-SCS 1971), Portland Cement Association (PCA 1956), and Wischmeier and Smith (1978). Approximately 3,318 acres (or 1 percent of the project area) is not currently mapped.

According to the soil surveys, a total of 152 soil complexes, associations, taxadjuncts, and variant map units occur within the ARPA. A total of 96 soil series, in various degrees of composition, comprise the 152 map units. For these soils, soil depth ranges from shallow to deep, soil drainage from somewhat poor to somewhat excessive, permeability from slow to rapid, water capacity from very low to high, runoff from slow to rapid, and susceptibility to water and wind erosion from slight to very severe. Basically, the soils are highly variable across this broad area.

3.3.2 Project Area Soil Limitations

Project area soil properties and limitations are discussed below. The topsoil that is categorized as *poor* and *fair* with *excess salt* (40,686 acres) indicates a potential reclamation problem (map M-9). If a soil is characterized with a moderate or severe limitation or a fair or poor suitability, it does not mean that it cannot be used for a particular use. It does mean that if the

CHAPTER 3. AFFECTED ENVIRONMENT

soil is used, it may be more costly and difficult to accomplish the particular use and can be difficult to reclaim and stabilize once disturbed.

Table 3-10 summarizes the data for soil factors of concern and their extent within the ARPA. Table 3-11 shows the five categories of soil factors of concern as they relate to each of the 21 6th-level hydrologic unit code (HUCs) boundaries (sub-watershed). Four of the five categories of concern are shaded dark for three HUCs on table 3-11 indicating that a high level of attention for any project-related activity is warranted. Fifteen HUCs have three high categories and four deserve the same high attention because of size and overlapping sensitivities. None of the 21 HUCs has all categories in the 0–20-percent range. HUCs are illustrated on map M-10.

3.3.2.1 Soil Texture and Strength

Clay and sandy soils have low strength under load and present severe limitations on road placement, construction, and maintenance (map M-11). A limitation is also placed on structure location and construction. Low-strength soils account for about 240,655 acres within the project area or about 89 percent of the total land surface area of the ARPA.

Shallow soils and very shallow soils comprise about 33,700 acres within the project area. These present difficulty in reclamation and pipeline placement. About 49,911 acres (which have a topsoil ranking of *good*) have moderate permeability.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-9. Top Soils with Excess Salts.



CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-10. Total Area (Acres) of Soil Factors of Concern within the ARPA.¹

Factor	Category	Acres²	% Total Area²
Water Erosion	No Data	3,318	1
	Slight	19,984	7
	Slight to Moderate	9,466	4
	Slight to Severe	154,090	57
	Moderate to Severe	13,873	5
	Severe	66,635	25
Wind Erosion	No Data	3,318	1
	Slight	27,473	10
	Slight to Moderate	81,532	30
	Moderate	132,242	49
	Moderate to Severe	17,082	6
	Severe	4,973	2
Runoff Potential	No Data	3,318	1
	Low	4,495	2
	Low to Moderate	3,616	1
	Low to High	12,901	5
	Moderate	38,549	14
	Moderate to High	90,926	34
	High	111,019	41
Topsoil Rating	No Data	3,318	1
	Poor	89,430	33
	Fair	123,851	46
	Good	49,911	19
Topsoil Rationale (Poor and Fair)	No Data	3,318	1
	Excess Salt	40,686	15
	Large Stones	6,830	3
	Too Clayey	160,187	59
	Too Sandy	2,638	1
	Wet	2,348	1
Road Rating	No Data	3,318	1
	Moderate	182,859	68
	Moderate to Severe	1,923	1
	Severe	78,370	29
Road Rationale	No Data	3,318	1
	Depth to Bedrock	17,997	7
	Low Strength	240,655	89
	Shrink-Swell Clays	58	0
	Too Sandy	2,502	1
	Wet	1,940	1

Notes:

¹ Based on BLM analysis of soil survey data provided by Texas Resource Consultants (1981) and Wells et al. (1981)

² Acres and percent total acres calculated on available soils data (266,717 acres) within the 270,035 acre project area.

Table 3-11. Total Area of Soil Factors of Concern by Subwatersheds within the Project Area.¹

HUC Name	Total Area of HUC in ARPA (Acres)	Water Erosion ²	Wind Erosion ²	Runoff Potential ²	Topsoil Rating ²	Road Rating ³
1. Dry Cow Creek	39,997	35,168	6,603	33,809	35,277	15,373
2. Cow Creek	25,027	18,650	470	17,097	16,071	5,056
3. Muddy Creek-Alamosa Gulch	21,439	19,102	1,723	19,702	13,517	3,420
4. Cherokee Creek	22,806	21,137	32	17,309	19,197	10,266
5. Deep Creek	22,791	21,329	0	18,760	19,206	13,575
6. Wild Cow Creek	21,060	15,682	354	13,758	14,746	8,599
7. Little Snake River-Cottonwood Creek	17,422	16,350	68	14,071	14,612	5,682
8. Separation Creek-Scotty Canyon	15,722	14,191	1,529	13,364	12,235	3,145
9. Upper Fillmore Creek	13,989	13,051	943	13,044	11,513	571
10. Muddy Creek-Blue Gap Draw	11,419	7,409	404	9,385	9,250	3,499
11. Hadsell Draw	11,158	9,747	1,443	9,972	8,418	656
12. Muddy Creek-Coal Mine Draw	8,871	7,296	581	7,988	7,230	447
13. Upper Sugar Creek	8,028	3,122	13	2,648	4,731	439
14. Little Snake River-Dutch Joe Creek	7,489	7,040	0	6,906	5,860	304
15. Muddy Creek-Antelope Creek	7,429	5,646	262	6,078	5,702	2,759
16. Muddy Creek-Robber's Gulch	7,162	5,355	0	5,384	5,085	1,523
17. Separation Creek-Red Rim	3,818	2,089	568	3,542	3,378	1,998
18. Lower Savery Creek	2,468	2,608	0	2,285	2,468	1,795
19. Bird Gulch	2,073	2,073	0	86	2,073	0
20. Lower Barrel Springs Draw	9	6	0	6	0	0
21. Middle Savery Creek	5	5	0	0	5	0
Totals	270,182	227,056	14,993	215,197	210,574	79,107

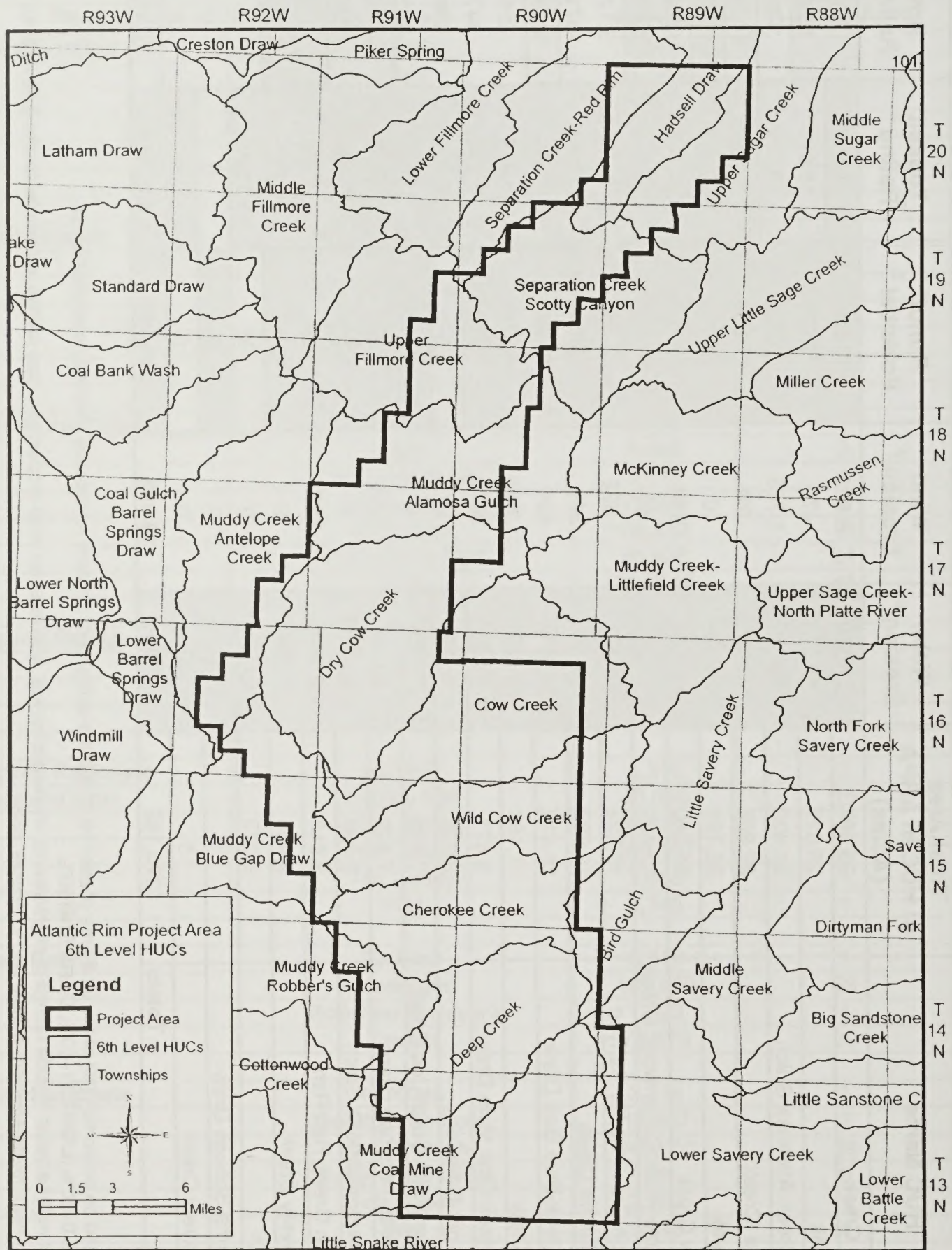
Notes:

¹ Shading based on proportion (%) of the total area of each HUC that the category of concern represents. Arbitrary classification is:
NONE 0-20%, **LIGHT** 21-50%, **DARK** 51-100%.

² Acres for water erosion include ratings of slight/severe, moderate/severe, & severe; for wind erosion and road ratings, moderate/severe & severe; for runoff potential, low/high, moderate/high, & high; and for topsoil, poor.

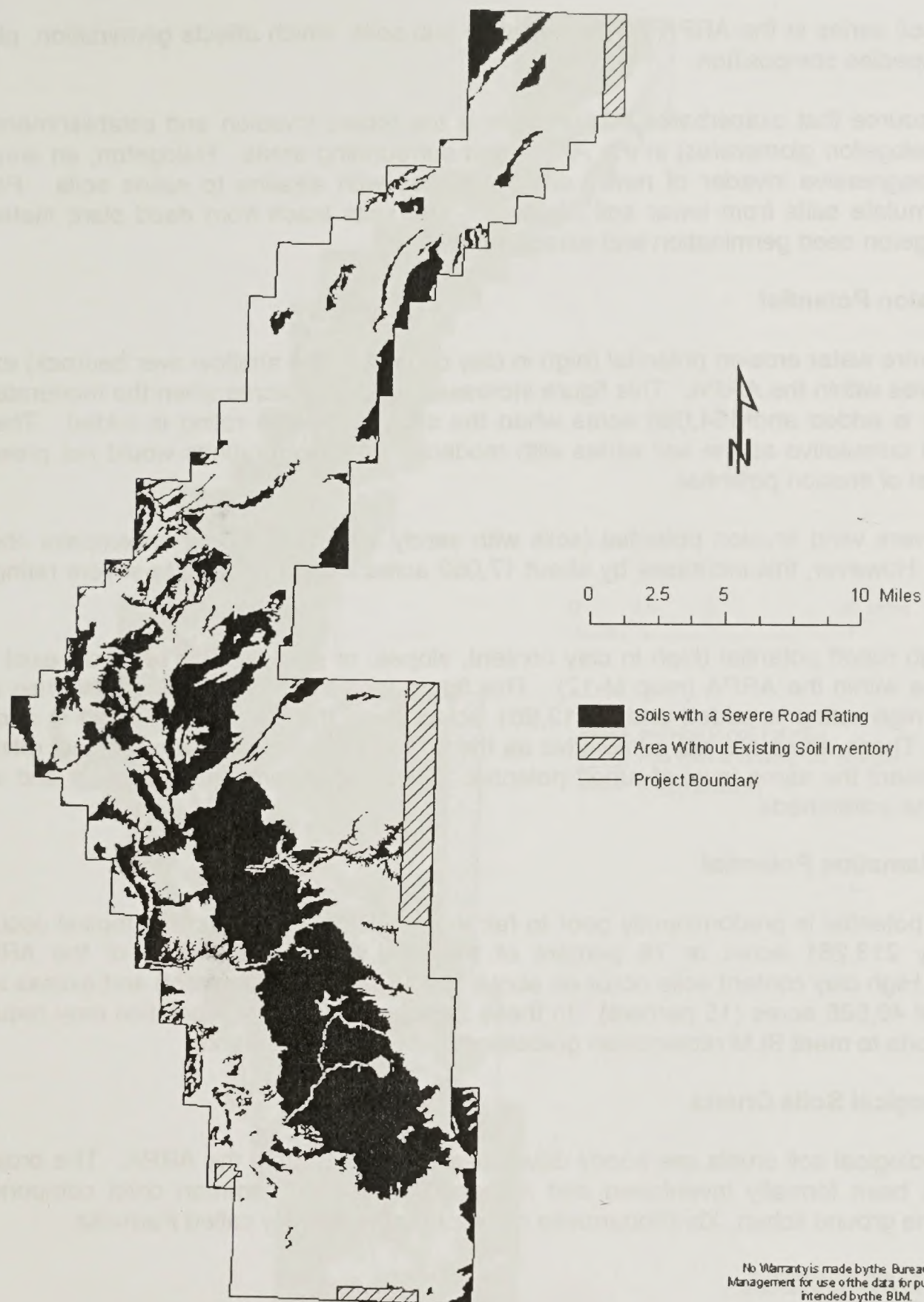
CHAPTER 3. AFFECTED ENVIRONMENT

Map M-10. Hydrologic Unit Code Boundaries.



CHAPTER 3. AFFECTED ENVIRONMENT

Map M-11. Soils with a Severe Road Rating.



CHAPTER 3. AFFECTED ENVIRONMENT

3.3.2.2 Soils with Excess Salts

Most of the soil series in the ARPA overlay alkaline sub-soils, which affects germination, plant growth, and species composition.

A biological source that exacerbates this problem is the recent invasion and establishment of halogeton (*Halogeton glomeratus*) in the ARPA and surrounding areas. Halogeton, an annual plant, is an aggressive invader of newly disturbed sites with alkaline to saline soils. Plant tissues accumulate salts from lower soil horizons. The salts leach from dead plant material favoring halogeton seed germination and establishment.

3.3.2.3 Erosion Potential

Soils with severe water erosion potential (high in clay content or are shallow over bedrock) exist on 66,635 acres within the ARPA. This figure increases by 13,873 acres when the moderate to severe rating is added and 154,090 acres when the slight to severe rating is added. These acres are not cumulative as the soil series with moderate and slight ratings would not present the same level of erosion potential.

Soils with severe wind erosion potential (soils with sandy surface textures) encompass about 4,973 acres. However, this increases by about 17,082 acres if the moderate to severe rating is added.

Soils with high runoff potential (high in clay content, slopes, or shallow over bedrock) exist on 111,019 acres within the ARPA (map M-12). This figure increases by 90,926 acres when the moderate to high rating is added and by 12,901 acres when the low to high rating is added (map M-12). These acres are not cumulative as the soil series with moderate and low ratings would not present the same level of runoff potential. These soils contribute sediment and salt loading into the watersheds.

3.3.2.4 Reclamation Potential

Reclamation potential is predominantly poor to fair in the ARPA. Poor and fair topsoil occupy approximately 213,281 acres or 79 percent of the total land surface area of the ARPA (map M-13). High clay content soils occur on about 160,187 acres (59 percent) and excess salt soils on about 40,686 acres (15 percent). In these areas, successful revegetation may require additional efforts to meet BLM reclamation guidelines and time requirements.

3.3.2.5 Biological Soils Crusts

In general, biological soil crusts are poorly developed or absent within the ARPA. The project area has not been formally inventoried and mapped. The most common crust component observed is the ground lichen, *Xanthoparmelia chlorochroa*, commonly called Parmelia.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-12. Soils with Elevated Runoff Potential.



CHAPTER 3. AFFECTED ENVIRONMENT

Map M-13. Soils with Poor/Fair Topsoil Ratings.



No Warranty is made by the Bureau of Land Management for use of the data for purposes not intended by the BLM.

3.3.3 Existing Soil Disturbances

Briefly, existing project-related disturbances to soil resources includes about 600 acres or 0.2 percent of the total land surface area of the ARPA. The majority of this total is 315 acres attributed to 210 gas well sites (116 IDP wells). Existing roads account for about 247 acres; compressor stations, 13 acres; transfer pumping stations, 1.0 acre; containment ponds, 25 acres; and deep injection well sites, 4 acres.

3.4 Water Resources

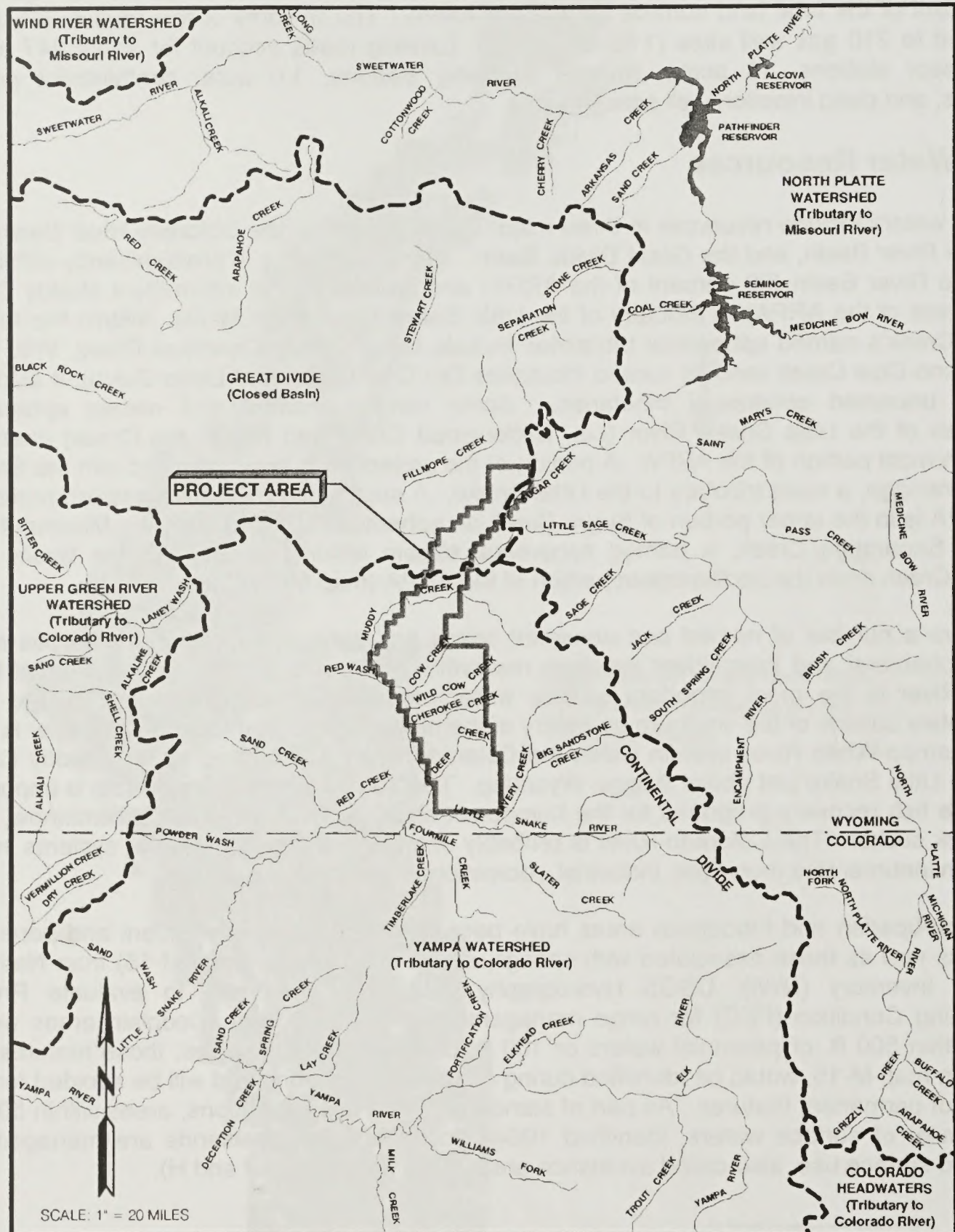
Surface waters include resources in three major drainage basins: the Colorado River Basin, the Missouri River Basin, and the Great Divide Basin. The project area is predominantly within the Colorado River Basin (80 percent of the ARPA) and drained by the intermittent Muddy Creek (69 percent of the ARPA), a tributary of the Little Snake River (map M-14). Within the ARPA, Muddy Creek's named ephemeral tributaries include Deep Creek, Cherokee Creek, Wild Cow Creek, and Cow Creek (and its named tributaries Dry Cow Creek and Deep Gulch); it also has multiple unnamed ephemeral tributaries. Some minor unnamed and named ephemeral tributaries of the Little Snake River (i.e., Cottonwood Creek and Dutch Joe Creek) drain the southern-most portion of the ARPA. A portion of the project area is also drained into the Savery Creek drainage, a main tributary to the Little Snake. A small part of the northeastern portion of the ARPA is in the upper portion of Sugar Creek an ephemeral stream within the Missouri River Basin. Separation Creek, a named ephemeral stream within the Great Divide Basin, and Filmore Creek drain the northwestern portion of the ARPA (map M-14).

There are a number of named and unnamed seeps and springs, as well as numerous man-made ephemeral and intermittent livestock reservoirs, wells and ponds. The perennial Little Snake River is the most important surface water resource in the general vicinity and falls immediately outside of the southern boundary of the project area. The Little Snake River is part of the Yampa-White River system within the Colorado River Basin (map M-14). Muddy Creek joins the Little Snake just above Baggs, Wyoming. The Yampa-White River system is important for native fish recovery programs for the humpback chub, bonytail, Colorado pikeminnow, and razorback sucker. The Colorado River is probably one of the most utilized river systems in the west with innumerable municipal, industrial, recreational, and agricultural uses.

Wetlands/Riparian and Floodplain areas have been identified along intermittent and perennial waters as well as those associated with springs, seeps and/or wells (map M-15) from National Wetland Inventory (NWI), USGS Hydrography data, and site visits to evaluate Proper Functioning Condition (PFC) for range management. Most 100 year floodplain areas would occur within 500 ft. of perennial waters or 100 ft. of ephemeral drainages, those features not shown on map M-15, would be identified during onsite investigations and will be avoided for the location of permanent features. As part of standard oil and gas mitigations, areas within 500 ft. (~1/10 mile) of surface waters, identified 100-yr floodplains, and wetlands are managed for controlled surface use, also called avoidance areas (See appendices J and H).

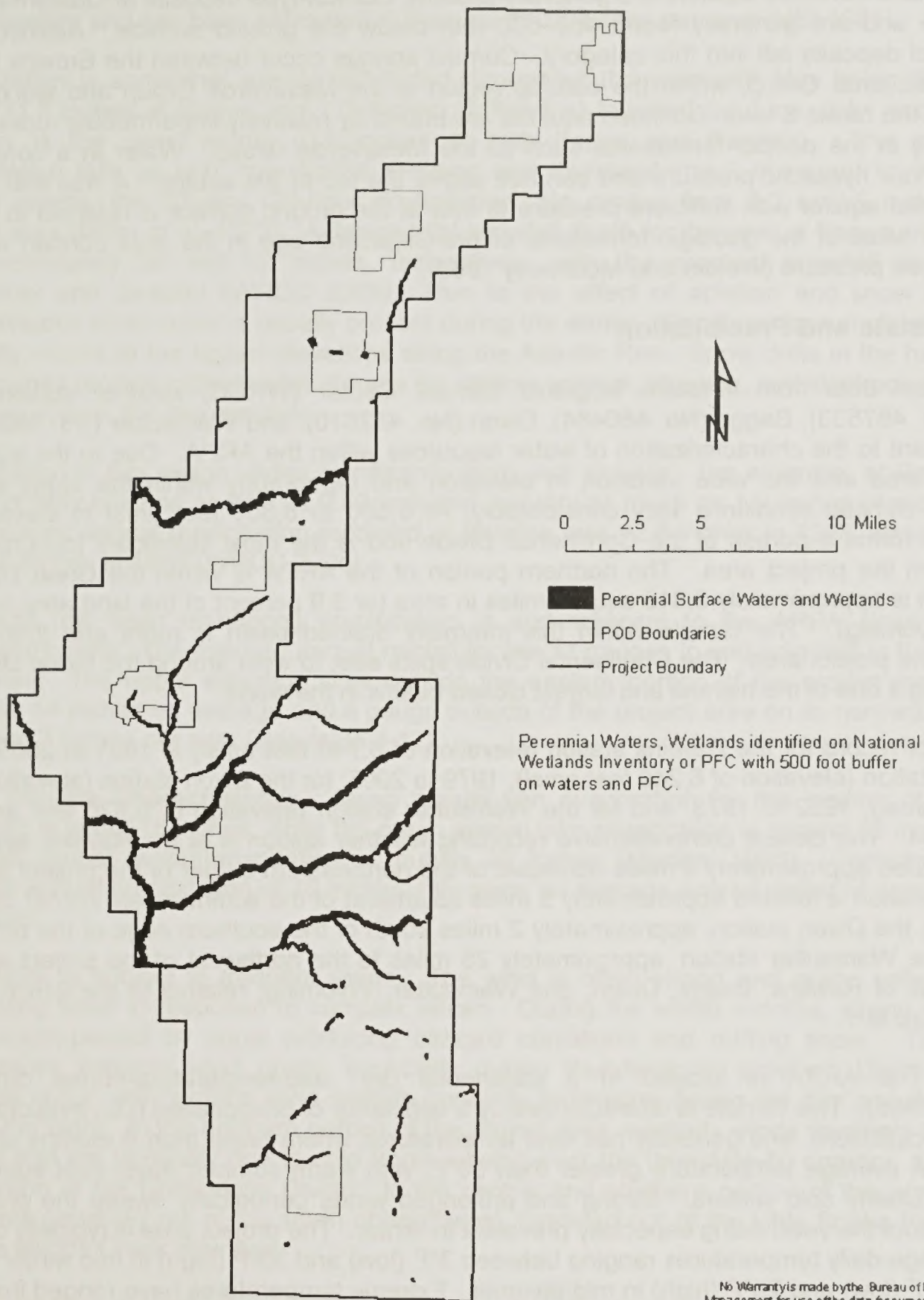
CHAPTER 3. AFFECTED ENVIRONMENT

Map M-14. Watershed Basins.



CHAPTER 3. AFFECTED ENVIRONMENT

Map M-15. Alternative C—Perennial Surface Waters and Wetlands.



CHAPTER 3. AFFECTED ENVIRONMENT

Groundwater resources include deep and shallow confined and unconfined (water table) aquifers. The unconfined aquifers are generally shallow, blanket-type deposits of Quaternary or Tertiary age and are generally found 400–600 feet below the ground surface. Alluvial and glacial gravel deposits fall into this category. Contact springs occur between the Browns Park and the Mesaverde Group, within the outcrop region of the Mesaverde Group and along the contact with the Lewis Shale. Confined aquifers are bound by relatively impermeable rocks and are generally in the deeper formations, such as the Mesaverde Group. Water in a confined aquifer is under hydraulic pressure and can rise above the top of the aquifer. A well that taps into a confined aquifer with sufficient pressure to flow at the ground surface is referred to as a flowing well. Most of the geologic formations of pre-Oligocene age in the area contain water under confined pressure (Welder and McGreevy 1966).

3.4.1 Climate and Precipitation

Meteorological data from Western Regional Climate Center (WRCC) weather stations in Rawlins (No. 487533), Baggs (No. 480484), Dixon (No. 482610), and Wamsutter (No. 489459) are all relevant to the characterization of water resources within the ARPA. Due to the size of the project area and the wide variation in elevation and topography within the study area, site-specific climatic conditions vary considerably. At 6,500 to 8,300 feet amsl in elevation, Atlantic Rim forms a portion of the Continental Divide and is the most significant topographic feature within the project area. The northern portion of the ARPA is within the Great Divide Basin, which is approximately 3,815 square miles in area (or 3.9 percent of the land area in the State of Wyoming). The climate within this internally drained basin is more arid than the balance of the project area. The Continental Divide splits east to west around the Great Divide Basin making it one of the highest and largest closed basins in the world.

The period of record for the Rawlins station (elevation of 6,740 feet amsl) is 1951 to 2005; for the Baggs station (elevation of 6,240 feet amsl), 1979 to 2005; for the Dixon station (elevation of 6,370 feet amsl), 1922 to 1978, and for the Wamsutter station (elevation of 6,820 feet amsl), 1948 to 2004. The closest comprehensive recording weather station is at the Rawlins airport, which is located approximately 9 miles northeast of the northeastern corner of the project area. The Baggs station is located approximately 3 miles southwest of the southwestern corner of the project area; the Dixon station, approximately 2 miles south of the southern edge of the project area; and the Wamsutter station, approximately 25 miles to the northwest of the project area. The locations of Rawlins, Baggs, Dixon, and Wamsutter, Wyoming, relative to the ARPA are shown on map M-1.

Climate. The ARPA is located in a continental dry, cold-temperature-boreal climate (Trewartha 1968). This climate is characterized by a deficiency of precipitation (i.e., evaporation exceeds precipitation), and generally has cold temperatures where fewer than 8 months of the year have an average temperature greater than 50°F, with warm summer days, cool summer nights, and bitterly cold winters. Strong and prolonged winds periodically sweep the project area throughout the year, being especially prevalent in winter. The project area is typically cool, having average daily temperatures ranging between 3°F (low) and 33°F (high) in mid winter and between 56°F (low) and 75°F (high) in mid summer. Extreme temperatures have ranged from –50°F to 100°F (both occurring in 1984). The frost-free period (at 32°F) generally occurs from mid-May to mid-September.

Precipitation. Mean annual precipitation is about 9–12 inches in the project area depending on elevation. Rawlins and Baggs have an annual average of 9.1 inches and 10.7 inches, respectively. Mean annual precipitation is 10.3 inches at Dixon and 6.8 inches at Wamsutter.

CHAPTER 3. AFFECTED ENVIRONMENT

Although no long-term data are available for precipitation along the topographically higher Atlantic Rim in the northern portion of the project area, precipitation can be assumed to increase with elevation and has been estimated in the past as 12 inches per year (HSI 1981).

Precipitation is somewhat evenly distributed throughout the year with May being the wettest month (1.5 inches at Baggs and 1.3 inches at Rawlins) followed by June, July, and October. January is the driest month (0.5 inches at both Baggs and Rawlins). The majority of precipitation falls as rain from frontal systems and thunderstorms. In regard to intensity of rainfall events, the 50-year, 24-hour precipitation rate ranges from 2.2 to 2.6 inches in the project area (Miller et al. 1973). Average total snowfall depth for the year at Baggs and Rawlins is approximately 38 and 52 inches, respectively, with the greatest snowfall occurring in December and January (WRCC 2005). Due to the effect of ablation and snow drifting, a discontinuous snow cover is usually present during the winter. Significant accumulation of snow normally occurs at the higher elevations along the Atlantic Rim. Snow drifts in the headwaters of drainages provide critical water storage for shallow springs, streams, and stockponds used as water sources in the late summer.

Precipitation in this region varies significantly from year to year. For example, at Rawlins, the month of May has had as little as 0.03 inch and January as much as 1.9 inches of precipitation. The greatest annual precipitation recorded at Rawlins was 12.6 inches in 1998, while the least was 4.9 inches in 1954 (WRCC 2005).

The BLM has been monitoring precipitation in and adjacent to the ARPA since 1987 for rangeland health. The average annual rainfall for the 11 gauges in and adjacent to the ARPA is 11 inches. The upper elevation sites outside the eastern portion of the project area had as much as 14 inches on average and a gauge outside of the project area on its northeastern side averaged 7 inches per year (See table 3-12).

Other Climate Characteristics. Mean annual pan evaporation for this portion of southern Wyoming is about 75 inches, while the mean annual lake evaporation is around 55 inches. The potential annual evapotranspiration is roughly 20 inches (Martner 1986). Compared to the average annual precipitation of 10 inches, this gives an average annual deficit of approximately 10 inches.

The ARPA is subject to frequent winds. The wind is often strong and gusty, reflecting and channeling flows in response to complex terrain. During the winter months, strong winds are often accompanied by snow producing blizzard conditions and drifting snow. The region experiences extreme wind gusts, especially during thunderstorm activity. Distinct diurnal changes occur, with surface wind speeds generally increasing during the day and decreasing during the night. In the northern portion of the project area, westerly winds dominate the winter climate and are generally due to cold fronts moving over the Interstate-80 corridor, a relatively low portion of the Continental Divide. In the central and southern portion of the project area, winds are generally out of the south or southwest, funneled out of the Little Snake River valley into the Muddy Creek drainage.

Violent weather is relatively common in the area; thunderstorms occur an average of 30 days per year and hail an average of 3 days per year. These meteorological and climatological characteristics of the project area combine to produce a predominantly dry, cool, and windy climate punctuated by quick, intense precipitation events.

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-12. BLM Range Rain Gauge Yearly Precipitation Averages.

Name	Location	Record	Minimum (inches)	Maximum (inches)	Average (inches)
Adams	SWSW Section 11 T17N: R92W	1987 - 2005	4.58	12.91	8.52
Fillmore Ranch	SENW Section 6 T18N: R90W	1995 - 2005	6.21	16.20	10.75
Echo Springs (No. 25)	NENE Section 6 T17N: R92W	1988–2005	4.08	10.48	7.25
Willows	NWNW Section 30 T17N: R90W	1986–1994, 1997–2005	6.01	17.06	10.26
Sulfur Springs	SENW Section 12 T17N: R90W	1987–1994, 1997–2005	6.12	17.70	10.97
Canary Grove	CNE Section 4 T16N: R89W	2000–2001, 2004–2005	11.08	15.54	12.73
Grizzly (Rendle Butte)	SENW Section 26 T16N: R89W	1987–1995, 1997–2005	8.07	18.66	12.35
Wild Cow	NESE Section 17 T15N: R90W	1987–1990, 1993–1994, 1997–2005	6.99	25.87	12.58
Little Robber 27	SWSW Section 7 T14N: R91W	1992–2005	5.42	15.14	9.60
Poison Buttes-124	SWSE Section 25 T13N: R92W	1992–2006	7.16	16.05	11.21
Morgan-Boyer	SESW Section 4 T13N: R89W	1986–1987, 1989–1991, 1997–2005	9.54	20.44	14.36
Average for all Gauges =					10.96
Minimum Average for all Gauges =					7.25
Maximum Average for all Gauges =					14.36

3.4.2 Surface Water Bodies

The Continental Divide splits the ARPA into three major drainage basins (map M-10). One leg of the Continental Divide runs east and west across the northern portion of the project area. Drainage south of this divide flows south and west to the Little Snake River (HUC 14050003) in the Colorado River Basin. A second leg of the Continental Divide runs north, dividing the northern portion of the project area. Drainage west of this divide flows north to Separation Lake in the closed Great Divide Basin (HUC 14040200). Drainage east of this divide flows northeast to the North Platte River (HUC 10180002) in the Missouri River Basin. The Continental Divide and the three major drainage basins are depicted on map M-14.

The locations of all USGS surface water gauging stations (both active and discontinued) within and near the ARPA are shown on map M-16. Table 3-13 summarizes the available streamflow data from these stations. With the exception of Muddy Creek Station No. 09258980 and North Platte River Station No. 06630000, none of the other nearby gauging stations is currently in use. Data collection has been discontinued for at least the last 8 years or was generally short-lived or seasonal at the inactive stations. As discussed in the climate section, precipitation is highly variable with small and large patterns of drought. The average flow conditions presented in table 3-13 are sufficient to compare streamflows relative to each other.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-16. Surface Waters and Monitoring Stations.

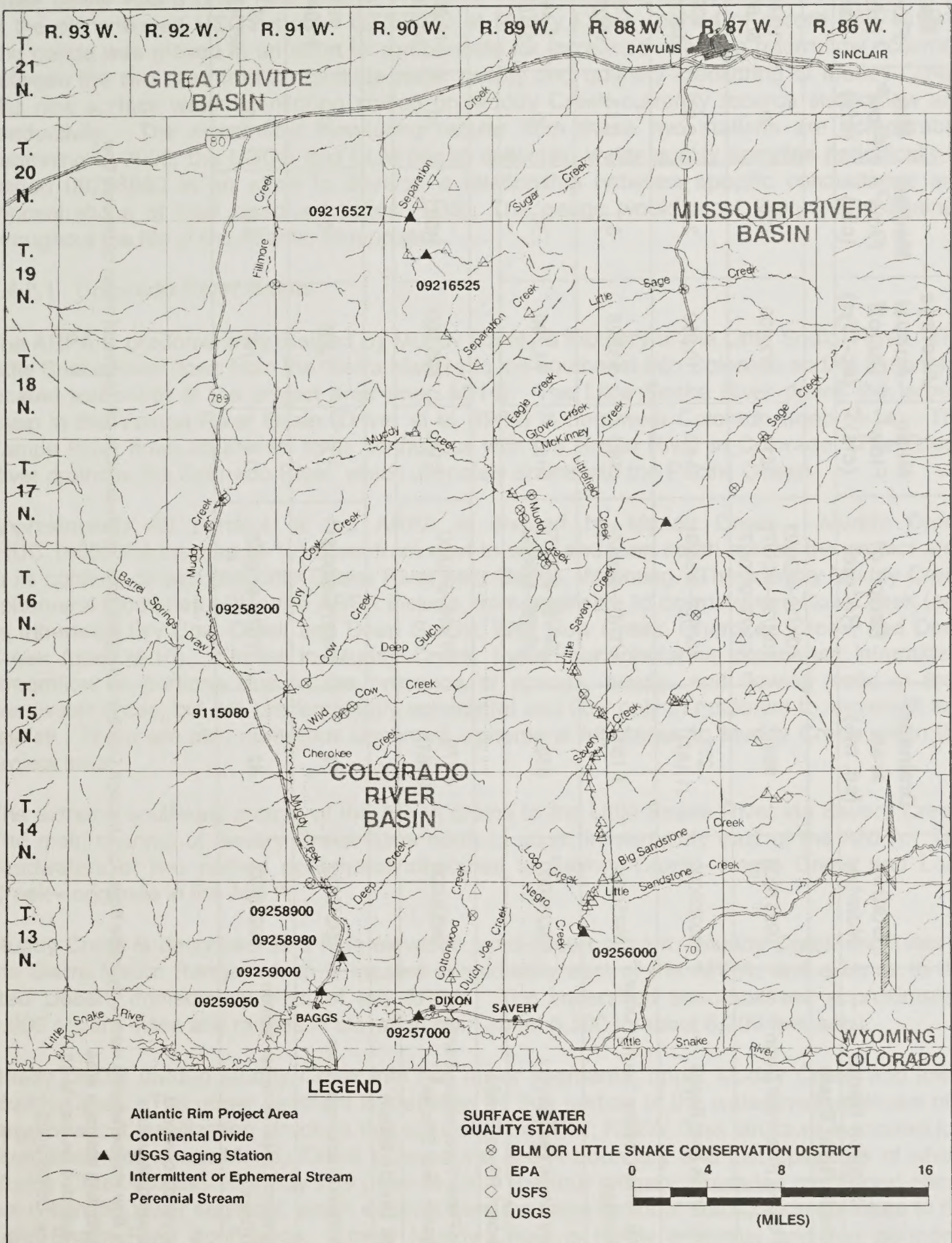


Table 3-13. Flow Statistics from USGS Gauging Stations Located within and near the ARPA.

Station Name	Station Number	Drainage area (sq. mi.)	Period of Record	Mean Flow ¹ (cfs)	Average Annual Runoff (ac-ft/yr)	Median Flow ² (cfs)	Min. Flow ² (cfs)	Max. Flow ² (cfs) Date
Colorado River Basin								
Little Snake River near Dixon	09257000	988	10/1/10–9/30/23 10/1/38–9/30/71 4/1/72–9/30/97 ³	514	372,400	100	0	10,400 5/16/84
Muddy Creek near Baggs	09259000	1,257 (1,187) ⁴	10/1/87–9/30/91	14.8	10,690	2.8	0.03	632 3/23/88
Muddy Creek below Young Draw near Baggs	09258980	1,150	4/17/04–present	19.1	13,828	3.7	0.13	236 1/12/05
Savery Creek near Savery	09256000	330	10/1/41–9/30/72 3/27/85–9/30/92	103	74,390	30	0	2,440 5/4/52
Missouri River Basin								
North Platte River above Seminole Reservoir, near Sinclair ⁵	06630000	4,175 (4,061) ⁴	7/1/39–9/30/00	1,140	825,800	450	70	14,800 6/11/86
Great Divide Basin								
Separation Creek near Riner	09216527	53	10/1/75–9/30/81	1.8	1,300	0	0	76 4/20/80
Separation Creek at upper station near Riner	09216525	42	7/1/75–9/30/75	1.3	na	0.8	0.5	21 9/11/75

Notes:¹ Over period of record² Of mean daily values³ Daily flow measurements were only made from April through October during this time; not included in calculation of mean or median flow.⁴ Contributing drainage area⁵ Not depicted on map M-16

Source: USGS 2005

CHAPTER 3. AFFECTED ENVIRONMENT

In 2004, the BLM RFO sponsored USGS surface water gauging station 09258980 at Muddy Creek below Young Draw near Baggs, Wyoming. This station is located immediately upstream of the discontinued USGS station 09259000 at Muddy Creek (period of record 1987–1991). The gauge was moved in an effort to compensate for increased irrigation return-flow occurring between the two sites and to reinitiate water quality and quantity monitoring of Muddy Creek. The new surface water monitoring station on Muddy Creek currently records streamflow and conductivity. The streamflow monitoring results from these two stations are comparable. Beginning in 2006, the USGS and BLM began collecting water quality samples periodically at station 09258980 in an effort to develop a relationship between specific conductance and concentrations of total dissolved solids (TDS). The gauge would most likely be maintained throughout the life of the Atlantic Rim project.

3.4.2.1 Colorado River Basin

The ARPA is predominantly drained by Muddy Creek, a tributary of the Little Snake River. The Little Snake River flows from the Sierra Madres to the southeast into Colorado and its channel is located just south of the project area (map M-14). The Little Snake River drains the largest basin in the Yampa River Basin (Driver et al. 1984) in northwest Colorado (map M-14). The Yampa River flows southwest to its confluence with the Green River in Colorado. The Green River drains to the Colorado River, which ultimately drains into the Pacific Ocean.

Approximately 69 percent of the ARPA is drained by Muddy Creek. Muddy Creek (HUC 14050004 on map M-10) flows from east to west and then south across the project area to its confluence with the Little Snake River near Baggs, Wyoming. The primary Muddy Creek ephemeral tributaries within the ARPA include, from upstream to downstream, Cow Creek (and its tributaries Dry Cow Creek and Deep Gulch), Wild Cow Creek, Cherokee Creek, and Deep Creek (map M-10). Similar to Muddy Creek, these four tributaries experience intermittent streamflow in portions due to the presence of springs, seeps, and flowing wells in their headwater areas, but are predominantly ephemeral and flow only in response to snowmelt and rainfall. There are also numerous unnamed, ephemeral tributaries to Muddy Creek within the project area.

The extreme southeast margin of the ARPA drains to the Little Snake River via Savery Creek. The main channel of Savery Creek flows north to south immediately east of the ARPA. The headwaters of two named ephemeral tributaries to Savery Creek—Negro Creek and Loco Creek—originate in the ARPA.

Muddy Creek is described as a high-elevation, cold-desert stream. Muddy Creek originates in the Sierra Madre Range, which is located immediately east of the ARPA, and extends to the Red Desert, immediately west of the ARPA. The watershed encompasses approximately 1,000 square miles and ranges in elevation from about 6,300 to about 8,200 feet amsl.

Beatty (2005) divided Muddy Creek into two major segments, upper Muddy Creek and lower Muddy Creek. The upper segment is identified as that portion of the watershed upstream of a large headcut stabilization structure that is located in T17N: R92W. This structure is located just downstream of where Muddy Creek crosses the ARPA boundary and just upstream of where Muddy Creek crosses Highway 789 (map M-16). The four primary tributaries mentioned above are within the lower segment, which extends from the large headcut stabilization structure to the Little Snake River confluence. Lower Muddy Creek is highly erosional and has abundant channel incisions (Beatty 2005). Channel substrates consist predominantly of very fine-grained

CHAPTER 3. AFFECTED ENVIRONMENT

sediments (sands, silts, and clays) in the lower segment and mostly rock substrates (gravels and cobbles) in the upper segment. In addition, a large wetland complex occurs on the reach of Muddy Creek that lies west of Highway 789 in T16N: R92W. This wetland area (George Dew Irrigated Meadows) consists of impoundments, man-made channels, vertical drop structures, headgate structures for water diversion, overflow spillways, and a braided stream channel network (Beatty 2005).

Streamflow in Muddy Creek and its tributaries varies with location along the drainage. An appreciable amount of snow accumulates at the higher elevations of the watershed, particularly in the more protected areas having pronounced gullies and canyons. Therefore, the snowmelt during the spring months accounts for a significant runoff event from tributaries draining these headwaters areas. Spring snowmelt runoff generally occurs from March through mid-June. Additional high flow events can occur in response to precipitation events during the summer and fall months. Numerous springs flow perennially within the ARPA that contribute low flows to the headwater tributaries; however, losses to seepage and evapotranspiration deplete these flows so the downstream reach of Muddy Creek flows intermittently.

Wetland habitat has been created around a number of flowing wells within the ARPA, but like springs, their contribution to streamflow is relatively insignificant due to seepage and evapotranspiration losses. A discussion on springs and flowing wells in the ARPA is included in section 3.4.5.3. The relative yield from rainstorms becomes more significant in the lower elevations of the drainage basin. Base flow and intermittency commonly occur from July through September, but can occur as early as April (Goertler 1992). Particularly within the lower segment of the Muddy Creek basin, tributary channels are generally dry and prone to flashy, periodic flood events from isolated thunderstorm systems from May to October.

Of the four nearby Colorado River Basin gauging stations (table 3-13) the Muddy Creek stations measure runoff from the largest drainage area. However, the average flow in Muddy Creek near Baggs, Wyoming, which is located near the mouth of Muddy Creek, is much less than that measured at the Little Snake River or Savery Creek gauging stations. This is because the headwaters of the Little Snake and portions of Savery Creek are in the Sierra Madre Range. The average (mean) Muddy Creek flow during the period of record at the discontinued gauging station was 14.8 cubic feet per second (cfs) and 19.1 cfs at the active station. Those flowrates can be compared to higher downstream rates of 514 cfs in the upper Little Snake River and 103 cfs in Savery Creek. In general, Muddy Creek experiences higher individual events and lower annual water yield due to climate conditions discussed previously.

Unit runoff, calculated by dividing the average annual runoff into the effective drainage area, is much lower in Muddy Creek. Unit runoff in the Muddy Creek drainage basin was about 0.2 inch per year, as compared to 7.1 inches per year in the upper Little Snake River drainage basin and 4.2 inches per year in the Savery Creek basin. The calculated median flows, which discount the effect of short-duration, high-volume flood events, are 2.8 cfs and 3.7 cfs at the two Muddy Creek stations, and 100 cfs and 30 cfs at the Little Snake River and Savery Creek stations, respectively. Excluding the active Muddy Creek gauging station, the median flow rates of the three Colorado River Basin stations were calculated only during the time period in which all three stations were active: October 1, 1987 through September 30, 1991, excluding the months of November through March. During this time period, the median flows in Muddy Creek, Little Snake River, and Savery Creek were 6.9 cfs, 13.5 cfs, and 25 cfs, respectively. These calculations demonstrate that some of the differences between the average and median flowrate calculations presented in table 3-13 may be caused by climactic differences between

CHAPTER 3. AFFECTED ENVIRONMENT

the differing periods of record. Because precipitation varies significantly from year to year, runoff varies significantly as well.

Much of the Muddy Creek watershed is managed by the BLM (section 3.6) and the land has historically been managed primarily for its range resources (agricultural uses, primarily grazing), as well as wildlife habitat, energy exploration and development, transportation, and recreational uses. Given these land uses and the area's unique geographic location and climatic characteristics, the Muddy Creek watershed has been extensively studied from water availability, water quality, and aquatic biology viewpoints.

A partial list of citations for this Muddy Creek research follows:

- Three native warm water fish species listed as BLM sensitive species co-exist in portions of both upper and lower Muddy Creek within the ARPA. These species have been extensively studied to determine habitat associations, life history, and interactions with non-native fish species (Quist et al. *in press*, Bower 2005). The lower portions of Muddy Creek have been studied to determine the role of anthropogenic disturbances as well as the distribution and life history of native fishes (Beatty 2005).
- Extensive cooperative management projects have been undertaken to improve watershed conditions. The RFO BLM has been a strong participant in many of these efforts in conjunction with water conservation districts, local government, and land owners (Thompson, J. 2001, NARCS 2000, Hicks and Warren 1992 and 1997, USDI-BLM 1987, Hicks et al. 1996, and Fanning 1986).

There has also been extensive research into surface-groundwater interactions, riparian system function, geomorphology, sediment dynamics, and other basic research (Peterson 1993, Goertler 1992, Middleton 1992, Skinner et al. 1989 and 1991, and Dolan and Wesche 1987).

3.4.2.2 Great Divide Basin

The northwest portion of the ARPA (roughly 20 percent) drains into the Great Divide Basin via Separation Creek including its tributary, Fillmore Creek. Separation Creek flows north to Separation Lake, which is a depression having no outlet located about 15 miles north of Rawlins. The Great Divide Basin is a closed basin and is bounded by the Continental Divide on all sides and has no hydrologic outlet (USGS 1976, Seaber et al. 1987). The Great Divide Basin is a relatively shallow depression with isolated buttes, pan-like depressions, and sparse vegetation. Numerous ephemeral streams flow toward the center of the Great Divide Basin before disappearing in the soil or ending in natural or man-made impoundments. There are some spring-fed systems like Battle Springs Flat and unique alkaline wetland systems around Chain Lakes. In general, streams within the Great Divide Basin are ephemeral, but can be intermittent in sections. These systems flow mainly in response to direct runoff from rainstorms and snowmelt (Lowham et al. 1976).

Springs provide some flow in the upstream reaches of the Separation Creek; however, groundwater inflow is not sufficient to maintain flow without snowmelt and rainfall. Some peak flows estimated for the creek in the downstream reaches are approximately 39 cfs for a 2-year flood and 420 cfs for a 50-year flood. Estimated annual discharge for downstream reaches of Separation Creek is 2,500 acre-feet (Larson and Zimmerman 1981).

CHAPTER 3. AFFECTED ENVIRONMENT

Separation Creek is classified by the WDEQ (2005) as a Class 4C stream, which is defined as those waters that do not support fisheries or other aquatic life uses and are not protected for those uses. Class 4C waters are however protected for agricultural, wildlife watering, and recreational uses. Beaver have greatly affected the streamflow, water quality, and aquatic habitat within the uppermost reaches of Separation Creek within Jep Canyon. The springs and seeps in Jep Canyon are not able to sustain streamflow throughout the year; however, they do sustain many of the beaver ponds in the headwater areas (Larson and Zimmerman 1981).

Groundwater is the most reliable source of water in Upper Separation Creek Basin. Springs and windmill-driven pumps presently supply water to wildlife and livestock (Larson and Zimmerman 1981).

3.4.2.3 Missouri River Basin

The northeast portion (roughly 3 percent) of the ARPA drains into the North Platte River via Sugar Creek. Although the USGS does not maintain a gauging station on Sugar Creek, limited instantaneous flow data are available from EPA and WDEQ monitoring stations near Rawlins (WRDS 2004). According to 14 instantaneous flow measurements collected at two stations during 1973, 1975, and 1976, Sugar Creek was flowing between 1 and 3 cfs, with a mean flow of 2.1 cfs. Sugar Creek drains the northwestern slope of the Atlantic Rim.

The headwaters of Little Sage Creek, a tributary to Sage Creek, begin at the eastern edge of the ARPA. The main stem of Sage Creek begins east of the ARPA and flows northeast to its confluence with the North Platte River between Saratoga and Rawlins, Wyoming. Limited flow data are available from two BLM gauging stations on Little Sage Creek (WRDS 2004). Based on 36 instantaneous flow measurements recorded during May through November 1978, and May through September 1979, the average Little Sage Creek flow during these months was 1.8 cfs; the median flow was 0.8 cfs.

3.4.3 Surface Water Rights

Based on a review of Wyoming State Engineer's Office (SEO) surface water rights, there are 195 permitted surface water rights within the originally scoped portion of the ARPA. Table 3-14 summarizes the rights according to designated uses. A second surface water rights search was performed for each of the major drainage basins intersecting the scoped ARPA. Table 3-15 summarizes the rights within each basin.

The Wyoming Game and Fish Department (WGFD) (2004a) maintains a state-wide database of lakes, reservoirs, and ponds. A search of the most recent WGFD database revealed the presence of about 15 reservoirs and ponds in the scoped ARPA. The waterbodies varied from 0.5 to 20 acres. Seven were owned or controlled by the BLM, six by private individuals, and one by the State of Wyoming. Table 3-16 lists the reservoirs and ponds catalogued by the WGFD.

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-14. Surface Water Rights within the ARPA.

SEO Use Designation	Surface Water Rights
Stock	161
Irrigation	12
Stock and irrigation	4
Domestic supply (in addition to stock and/or irrigation use)	10
Industrial	1
Reservoir supply	3
Wildlife and fish propagation	4
Total surface water rights within the ARPA	195

Table 3-15. Surface Water Rights within Major Drainage Areas.

SEO Use Designation	Muddy Creek	Savery Creek	Separation Creek ¹	Sage Creek	Sugar Creek
Stock	272	145	43	51	22
Irrigation	26	60	7	36	13
Stock and irrigation	8	7	6	4	6
Domestic supply (in addition to stock and/or irrigation use)	12	18	3	16	15
Industrial - pollution control and flood control	13	9	-	1	6
Municipal	-	-	-	14	31
Reservoir supply	2	1	-	3	1
Railroad and steam supply	-	-	-	13	2
Wetland, wildlife, and fish propagation	9	3	-	1	-
Mining	-	9	-	-	-
Power development	-	2	-	1	2
Recreation	-	2	1	1	-
(none listed)	2	1	-	1	-
Totals by Drainage Area	344	257	60	142	98

Note:

¹ To confluence with Fillmore Creek

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-16. Reservoirs, Lakes, and Ponds in the ARPA.

Water Body	Source Water	Acres	Ownership
Brazel Reservoir	Dry Cow Creek	1	USDI-BLM
Doty Mountain Reservoir	Dry Cow Creek	20	USDI-BLM
Dry Cow Reservoir	Dry Cow Creek	2	USDI-BLM
Horse Gulch Reservoir	Muddy Creek	3	Private
J-O Reservoir	Cow Creek	8	State
J-O Reservoir #1	Dry Cow Creek	1.5	Private
J-O Reservoir #2	Dry Cow Creek	2	Private
J-O Reservoir #3	Dry Cow Creek	3	Private
J-O Reservoir #4	Dry Cow Creek	1	Private
Lower Deep Gulch Pond	Cow Creek	3	USDI-BLM
Retention Reservoir	Deep Creek	5	USDI-BLM
Smiley Draw Reservoir	Cherokee Creek	6	USDI-BLM
Willie Reservoir	Loco Creek	2.5	Private
Willow Road Pond	Dry Cow Creek	0.5	USDI-BLM

Source: WGFD (2004a)

3.4.4 Surface Water Quality

Various federal and state agencies, including the USGS, USDI-BLM, EPA, and WDEQ, have monitored surface water quality in and around the ARPA. Surface water samples have been analyzed for physical and chemical properties, salinity, major ions, metals, radionuclides, and specific toxins. These agencies' surface water quality sampling locations in and around the ARPA are depicted on map M-16. The results of chemical analyses for most surface water samples collected within the ARPA can be accessed through the State of Wyoming's Water Resources Data System (at web site <http://www.wrds.uwyo.edu/>) (WRDS 2004) and the USGS's database (at web site <http://waterdata.usgs.gov/usa/nwis/>) (USGS 2005).

In the arid, high plains of southwestern Wyoming, surface water quality, like streamflow, is variable both spatially and temporally. Perennial stream water quality is generally of better quality than that of the ephemeral and intermittent streams. The quality of runoff is largely dependent upon the amount of salts, sediments, and organic materials that accumulate in dry stream channels between periods of runoff. Factors that can govern the amount of buildup of these materials are the basin's physical characteristics, land uses, and season of the year. Periodic flushing of accumulated salts and sediments from the ephemeral and intermittent streams occurs during flow events, which is the only time that water quality samples can be collected, accounting for greater concentrations of dissolved and suspended solids recorded in the analyses.

Water quality is classified by the State of Wyoming based on beneficial uses. Tables 3-17 and 3-18 show the classifications of Wyoming surface waters located in or near the ARPA.

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-17. Classification of ARPA Surface Waters Based on Protected Uses.

	Outstanding Values	Drinking Water	Game Fish	Non-Game Fish	Fish Consumption	Other Aquatic Life	Recreation	Wildlife	Agriculture	Industry	Scenic Value
1 ¹	Yes ²	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2AB	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4C	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Notes:

¹ Only those classifications used in the ARPA are included in this list.

² "Yes" means that it is protected for the use specified and "No" means that it is not.

Table 3-18. Classification of Streams in the ARPA.

Surface Water	Classification
<i>Colorado River Basin</i>	
Little Snake River	2AB
Muddy Creek (mouth to Section 29, T17N, R89W)	2C
Muddy Creek (remainder)	2AB
McKinney Creek	2AB
Cow Creek	2C
Dry Cow Creek	3B
Wild Cow Creek	2C
Cherokee Creek	2C
Deep Creek	3B
Savery Creek	2AB
Loco Creek	2C
Negro Creek	3B
<i>Missouri River Basin</i>	
Separation Creek	4C
<i>North Platte River Basin</i>	
North Platte River (Sage Creek to Colorado state line)	1
North Platte River (Kortes Dam to Sage Creek)	2AB
Sage Creek	2AB
Little Sage Creek	2C
Sugar Creek	3B

Source: WDEQ (2005)

CHAPTER 3. AFFECTED ENVIRONMENT

3.4.4.1 Baseline Water Quality Data

A summary of the water quality data from each of seven USGS surface water sampling stations located in the Little Snake River watershed within the scoped ARPA (two on Little Snake River, three on Muddy Creek, and one each on Cow Creek and Dry Cow Creek) are shown on table 3-19. Sampling periods for each station are also noted in table 3-19. The two Little Snake River stations represent perennial stream surface water quality in the area; the three Muddy Creek stations represent intermittent stream surface water quality in the ARPA, while the water quality in ephemeral streams is represented by the Cow Creek and Dry Cow Creek monitoring stations.

As table 3-19 indicates, more specific conductance measurements have been recorded than TDS concentrations at these seven surface water sampling stations. For individual streams, a good relationship can commonly be established between specific conductance and TDS concentrations. In general, as ionic concentrations increase, conductance increases (Hem 1970). The USGS and BLM began collecting periodic samples in 2006 for TDS concentrations at Muddy Creek Station 09258980 so that a relationship can be determined between conductivity and TDS concentration.

Surface water quality within the Muddy Creek drainage basin, like streamflow, is variable both spatially and temporally. The ephemeral stream water quality, represented by the two Muddy Creek tributaries, is characterized by high and widely variable conductance and TDS concentrations (TDS ranges from about 560 to over 3,000 milligrams per liter [mg/L]). The predominant ions are sodium and bicarbonate. The intermittent stream water quality, represented by Muddy Creek, is characterized by moderate conductance and TDS concentrations (TDS ranges from around 350 to 1,400 mg/L). The predominant ions are sodium, sulfate, and bicarbonate. The perennial stream water quality, represented by Little Snake River, is characterized by significantly reduced conductance and TDS concentrations (TDS ranges from around 50 to 550 mg/L). The water type is calcium bicarbonate. Note that limited samples were available from the ephemeral tributaries, and the samples that were available tended not to always coincide with the infrequent flood events.

Short-duration flood events in response to precipitation or snow melt typically cause an abrupt, temporary increase in the concentration of dissolved constituents. The larger variation and relatively higher conductance values measured in the ephemeral streams, where base flow is responsible for a small part of the overall streamflow, illustrate how the quality of runoff from those stream reaches is influenced by flood events.

Based upon the historical USGS surface water quality analyses (table 3-19), the average TDS concentration in the perennial Little Snake River below Baggs, Wyoming, was about 250 mg/L, compared to roughly 900 mg/L in the intermittent Muddy Creek just upstream of its confluence with the Little Snake River, and almost 2,000 mg/L in the ephemeral Cow Creek near its mouth. Though a limited number of TDS analyses are available from Muddy Creek at Station No. 09259000, the average TDS concentration at this location was estimated using a regression analysis of conductance values recorded at that station and at Station 09258980.

As indicated in table 3-19, surface waters in the ARPA are of moderately basic (or high) pH (8.1 to 9.2) and have a moderate concentration of dissolved oxygen (9 to 11 mg/L). WDEQ (2005) defines 9.0 as the upper pH limit for full aquatic life support. Hardness varied between soft

CHAPTER 3. AFFECTED ENVIRONMENT

(37 mg/L Calcium Carbonate [CaCO₃]) in Cow Creek to hard (315 mg/L CaCO₃) in Muddy Creek.

Table 3-19. Surface Water Quality in the ARPA.

Station Number	USGS Surface Water Quality Station						
	Little Snake River	Little Snake River	Muddy Creek	Muddy Creek	Muddy Creek	Cow Creek	Dry Cow Creek
	09257000	09259050	09258900	09259000	09258980	09115080	09258200
Sample period	1957-1988	1980-1997	1976-1978	1957-1991	May 2005-present ¹	1978-1979	1975-1980
Number of samples ²	107	100	3	41	nm	20	9
pH	8.1	8.1	8.6	8.2	nm	9.2	8.6
Conductance, μ hos/cm (mean)	259 ₍₃₄₎	366 ₍₉₀₎	1,350 ₍₂₎	966 ₍₃₅₎	1,300 ₍₁₁₁₎	2,925 ₍₁₈₎	2,162 ₍₅₎
Conductance, μ hos/cm (min.)	82	87	600	529	598	700	460
Conductance, μ hos/cm (max.)	460	855	2,100	1,790	3,550	7,500	3,800
TDS (mean)	158 ₍₉₎	243 ₍₁₇₎	913 ₍₂₎	346 ₍₁₎	nm	1,801 ₍₆₎	292 ₍₁₎
TDS (min.)	46	87	396	346	nm	561	292
TDS (max.)	260	540	1,430	346	nm	3,013	292
Suspended solids ³ (mean)	154 ₍₁₀₁₎	228 ₍₂₅₎	6,198 ₍₂₎	3,191 ₍₄₁₎	nm	133 ₍₆₎	1111 ₍₉₎
Suspended solids ³ (min.)	4	6	195	7	nm	30	8
Suspended solids ³ (max.)	1,180	852	12,200	22,500	nm	315	6,180
Turbidity, JTU	13	167	1,260	nm	nm	284	1,013
Calcium	30	34	54	42	nm	19	9
Magnesium	8	12	44	40	nm	31	4
Potassium	2	2	7	9	nm	11	4
Sodium	11	26	200	286	nm	560	98
Bicarbonate	159	190	373	308	nm	870	170
Sulfate	25	54	380	320	nm	181	65
Chloride	3	2	65	32	nm	132	21
Iron, μ g/L	74	164	105	nm	nm	2,903	200
Hardness (CaCO ₃)	111	151	315	270	nm	174	37
Dissolved Oxygen	9	10	11	10	nm	9	11

Notes:

¹ Daily mean values analyzed May 27, 2005 to September 14, 2005.

² Total number of grab samples analyzed; not every parameter was analyzed in every sample.

³ Total concentration; except as noted here, all reported values represent dissolved concentrations.

JTU – Jackson turbidity units

nm - Not measured.

₍₃₄₎ - Number of samples analyzed for that parameter.

All units are mg/L except as noted.

CHAPTER 3. AFFECTED ENVIRONMENT

As the name Muddy Creek implies, the suspended solids concentration is typically high. Suspended sediment concentrations, like TDS concentrations, are greater in the ephemeral and intermittent streams than the perennial Little Snake River. The ephemeral and intermittent channels, as well as the basin's surface, that have periods of no flow accumulate loose material due to weathering, bank caving, livestock and wildlife movement, and wind deposits. This loose material is then readily picked up by the turbulent first flows of a flood event. Once the channels and basin surface have been flushed, then the suspended sediment concentration is dependent upon the magnitude of the runoff event and the erodability of the land surface and stream channel.

As stated in the reclamation potential discussion in section 3.3.2.4, poor to fair topsoils occupy approximately 79 percent of the total land surface of the ARPA; therefore, reclamation potential is fair to poor. This is due to factors including steep slopes and high clay and silt content soils that can cause moderate to severe water and wind erosion and have moderate to high runoff potential. The relatively high total suspended solids (TSS) concentrations recorded in Muddy Creek flows (concentrations averaging about 6,200 mg/L and a high value of 12,200 mg/L) are indicative of the relatively large percentage of the land surface in the basin that has high (41 percent) or moderate to high (about 34 percent) runoff potential (section 3.3).

Turbidity varied from 13 Jackson turbidity units (JTU) in Little Snake River to 1,260 JTU in Muddy Creek. The moderate to high turbidity measurements were likely caused by the moderate to high measurements of suspended sediment (predominantly clay particles and organics).

Table 3-20 presents a summary of all Muddy Creek water quality results that were available from the State of Wyoming's Water Resource Data Center (WRDS) database before the installation of the new USGS Station 09258980 in 2004. Constituent concentrations in table 3—20 represent the geometric mean of all the respective water quality analytical results over the period of record (1933, 1976, 1978, 1979, and 1986 through 1993) at 16 separate water quality sampling stations throughout the Muddy Creek drainage basin (map M-16). The average specific conductance is moderate at 599 micromhos per centimeter ($\mu\text{mhos/cm}$), pH is slightly basic at 8.2, the TDS concentration is 442 mg/L, and the water is a calcium-bicarbonate type. High TSS (maximum concentration of 22,500 mg/L), coupled with high fecal coliform bacteria concentrations indicate that Muddy Creek would likely require disinfection and filtration if it were to be used as a potable supply. Naturally occurring radionuclides may also restrict the use of Muddy Creek as a drinking water supply. Mean uranium, gross alpha, and gross beta concentrations were 11 micrograms per liter ($\mu\text{g/L}$), 22 picocuries per liter (pCi/L), and 4.6 pCi/L, respectively. It is important to emphasize that the values in table 3-20 do not necessarily represent the surface water quality at any particular location within the Muddy Creek drainage basin during any particular season of the year, but rather, are the composite representation of Muddy Creek water quality.

Table 3-20. Muddy Creek Water Quality.

Parameter	Unit	Mean ¹	Count	Max	Min
Specific conductance	$\mu\text{mhos/cm}$	599	128	2,450	324
Total dissolved solids	mg/L	442	31	1,430	227
Total suspended solids	mg/L	144	56	22,500	0.2
Turbidity	NTU	23	86	2,500	1.1

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-20. Muddy Creek Water Quality.

Parameter	Unit	Mean ¹	Count	Max	Min
pH	standard units	8.2	137	8.7	7.2
Dissolved oxygen	mg/L	9.0	71	17.6	4.0
Hardness as CaCO ₃	mg/L	258	134	555	100
Alkalinity as CaCO ₃	mg/L	182	113	992	83
Calcium	mg/L	76	136	171	22
Magnesium	mg/L	12	136	84	3.9
Sodium	mg/L	15	135	300	0.3
Potassium	mg/L	4.3	135	51	1.6
Sodium adsorption ratio	none	0.43	135	10	0.01
Sulfate	mg/l	116	136	668	1.1
Chloride	mg/L	12	106	359	0.7
Bicarbonate	mg/L	214	135	2729	109
Carbonate	mg/L	1.2	115	47	< 1
Fluoride	mg/L	0.3	100	2.8	< 0.1
Silica	mg/L	15	8	39	5.6
Coliforms, fecal	count/100 mL	78	41	1,650	3
Aluminum, dissolved	µg/L	50 ²	1	< 100	< 100
Arsenic, dissolved	µg/L	2.0	1	2	2
Barium, dissolved	µg/L	50	1	< 100	< 100
Beryllium, dissolved	µg/L	nm ³	nm	nm	nm
Boron, dissolved	µg/L	64	5	360	10
Cadmium, dissolved	µg/L	0.5	1	< 1	< 1
Chromium, dissolved	µg/L	0.5	1	< 1	< 1
Cobalt, dissolved	µg/L	nm	nm	nm	nm
Copper, dissolved	µg/L	1.0	1	< 2	< 2
Iron, dissolved	µg/L	51	9	200	< 30
Lead, dissolved	µg/L	0.5	1	< 1	< 1
Manganese, dissolved	µg/L	21	5	90	< 10
Mercury, dissolved	µg/L	0.25	1	< 0.5	< 0.5
Molybdenum, dissolved	µg/L	8	1	8	8
Selenium, dissolved	µg/L	3	1	3	3
Silver, dissolved	µg/L	0.5	1	< 1	< 1
Uranium, dissolved	µg/L	11	2	16	6.9
Zinc, dissolved	µg/L	10	1	< 20	< 20
Radium 226	pCi/L	0.5	2	1.2	0.17
Gross alpha	pCi/L	22	2	23	22
Gross beta	pCi/L	4.6	2	6.5	3.3

Notes:

¹ geometric mean

² assumed half of detection limits for samples reporting "no detect"

³ nm = not measured

Source: WRDS (2002)

CHAPTER 3. AFFECTED ENVIRONMENT

Figure 3-2 compares the major ion characterization of each surface waterway. The major ion concentrations from table 3-20 are plotted on figure 3-2 for Muddy Creek, as are the geometric means of the major ions determined from all water samples that have been collected from the other streams depicted. Ephemeral Dry Cow Creek, Cow Creek, Wild Cow Creek, and Little Sage Creek exhibited sodium dominance, while the intermittent Muddy Creek and the perennial Little Snake River and North Platte River exhibited calcium dominance. With the exception of Separation Creek which is sulfate dominant, all surface waterways exhibited bicarbonate anion dominance.

Figure 3-3 compares the irrigation suitability of the streams in and around the ARPA. Again, geometric means of the specific conductance and sodium adsorption ratio (SAR) values were determined from all water quality samples available from the State of Wyoming's WRDS (2002) database for these streams. Figure 3-3 combines USDA (1954) and Ayers and Wescott (1985) information on classifying irrigation waters. The irrigation suitability is a function of SAR and salinity as measured by specific conductance. The perennial and intermittent streams are all in the C1-S2 category. The low salinity (C1) classification indicates that the water can be used for all crops and soils where salt toxicity is concerned. The moderate sodium (S2) classification indicates that the water may cause clay particles in irrigated soils to swell and disperse and thereby reduce the soil infiltration rate. The ephemeral streams in the ARPA are generally in the C2-S2 category indicating that the yield of salt-sensitive crops may be reduced.

When flows are available and based on average values, Muddy Creek is moderately suitable as an irrigation water supply. As shown on figure 3-3, Muddy Creek does not pose a salinity hazard to irrigated crops. However, due to the flashy flows and limited data, it would be difficult to be very confident about this determination. Muddy Creek in general is a good supply of water for livestock and wildlife when it flows (e.g., after a flushing event subsides), and would be suitable for crops such as native hay. The George Dew wetland complex near Dad is the primary location where Muddy Creek is used for irrigation (the wetland complex is formed by spreader dykes along Muddy Creek). This area is used for cattle and there is a diversion for small scale bottomland irrigation along Muddy Creek south of Dad.

Numerous miscellaneous surface water quality samples were collected from various locations within the upper Separation Creek watershed, both within and outside of the ARPA, as part of the Separation Creek study by Larson and Zimmerman (1981). Specific conductance measured at USGS Station 09216527 (map M-16) ranged from 200 to 2,000 $\mu\text{mhos/cm}$ (or a TDS concentration of about 1,400 mg/L). Surface water in Separation Creek tends to be slightly to highly alkaline, having an average pH of 8.0. Total phosphorous concentration averaged 0.16 mg/L, which is slightly above the EPA criterion for stream protection (0.1 mg/L). Separation Creek carries and deposits sediments into the Great Divide Basin. Suspended sediments predominantly consist of clay and silt. Separation Creek has an average suspended sediment concentration of 506 mg/L. The chemical quality of upper Separation Creek streamflow was found by Larson and Zimmerman (1981) to be suitable for its present uses, which are livestock watering and irrigation of native hay.

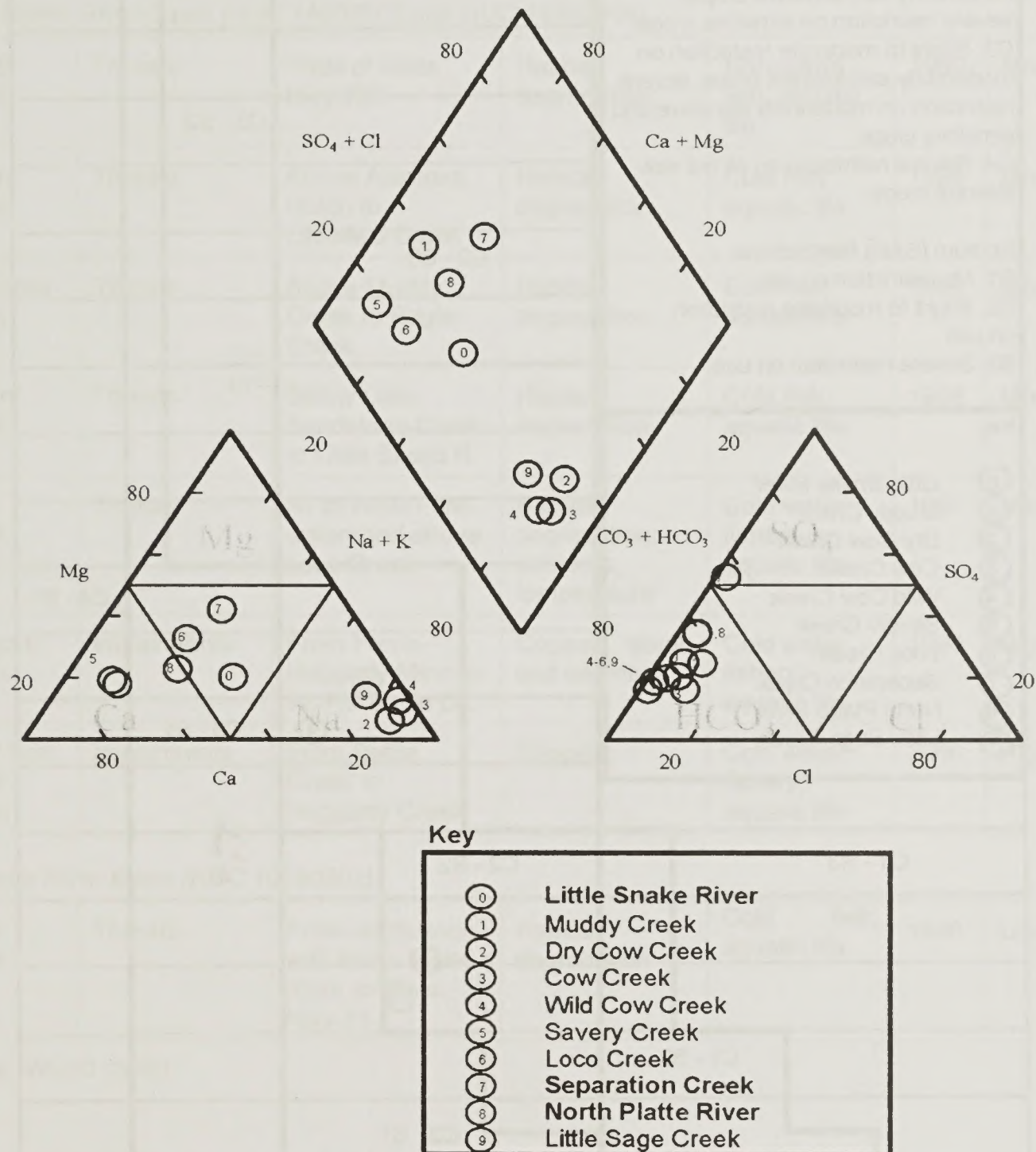
3.4.4.2 Waterbodies with Impairments or Threats

Various streams in the ARPA or near the ARPA are identified in Wyoming's 2006 305(b) Water Quality Assessment Report (WDEQ 2006) as having water quality impairments or threats. Table 3-21 summarizes the streams and potential problem parameters. Map M-17 depicts the threatened or impaired stream segments in and around the ARPA. Impaired or threatened

CHAPTER 3. AFFECTED ENVIRONMENT

streams in the Little Snake River watershed (HUC 14050003 and 14050004) include portions of Muddy Creek, McKinney Creek, West Fork Loco Creek, Savery Creek, Haggarty Creek, and West Fork Battle Creek.

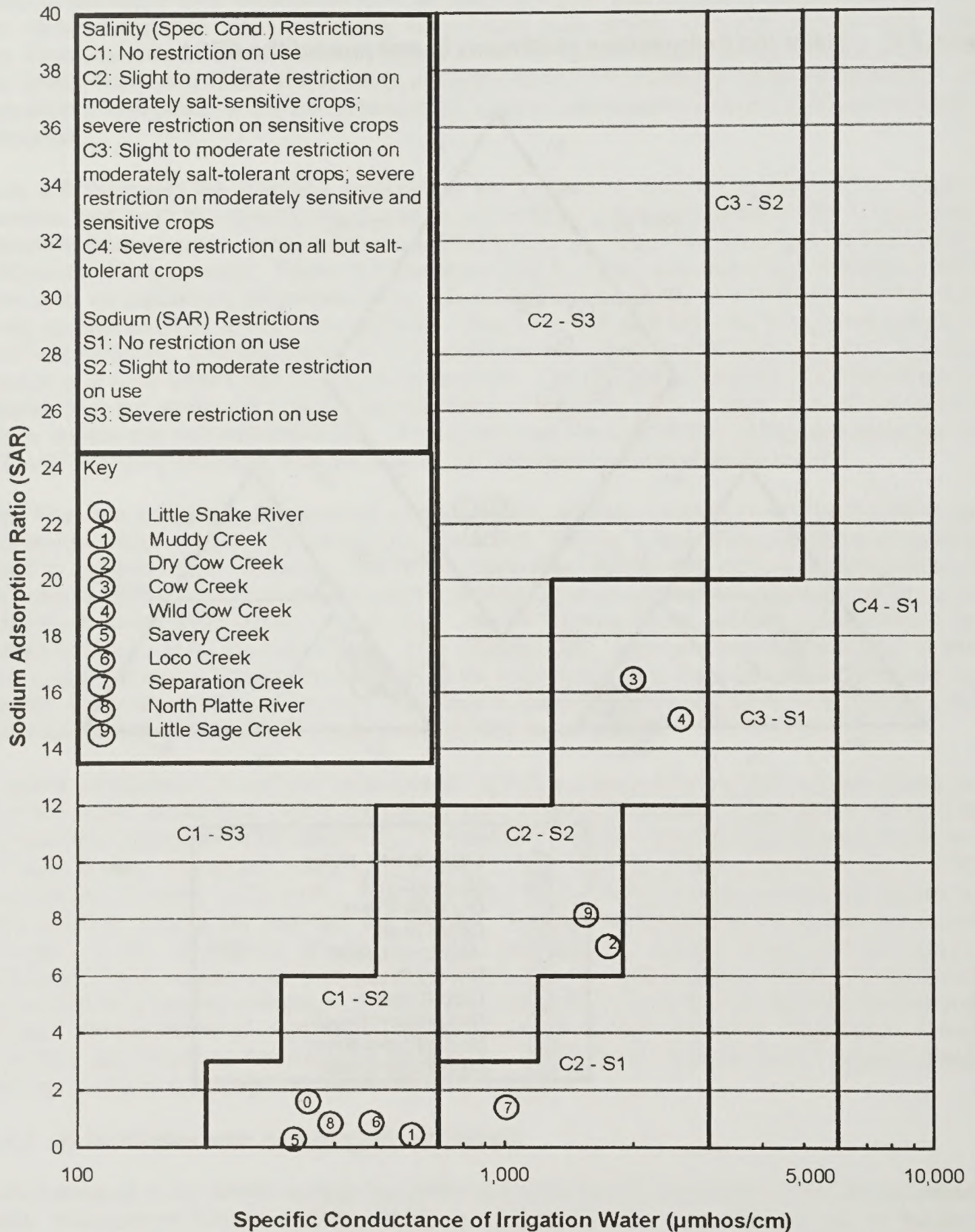
Figure 3-2. Major Ion Composition of Streams in and around the ARPA.



Data source: WRDS (2002)

CHAPTER 3. AFFECTED ENVIRONMENT

Figure 3-3. Irrigation Suitability of Streams in and around the ARPA.



Note: Figure modified from USDA Agriculture Handbook 60 (1954) to include Hansen et al. (1999) classification lines.

CHAPTER 3. AFFECTED ENVIRONMENT

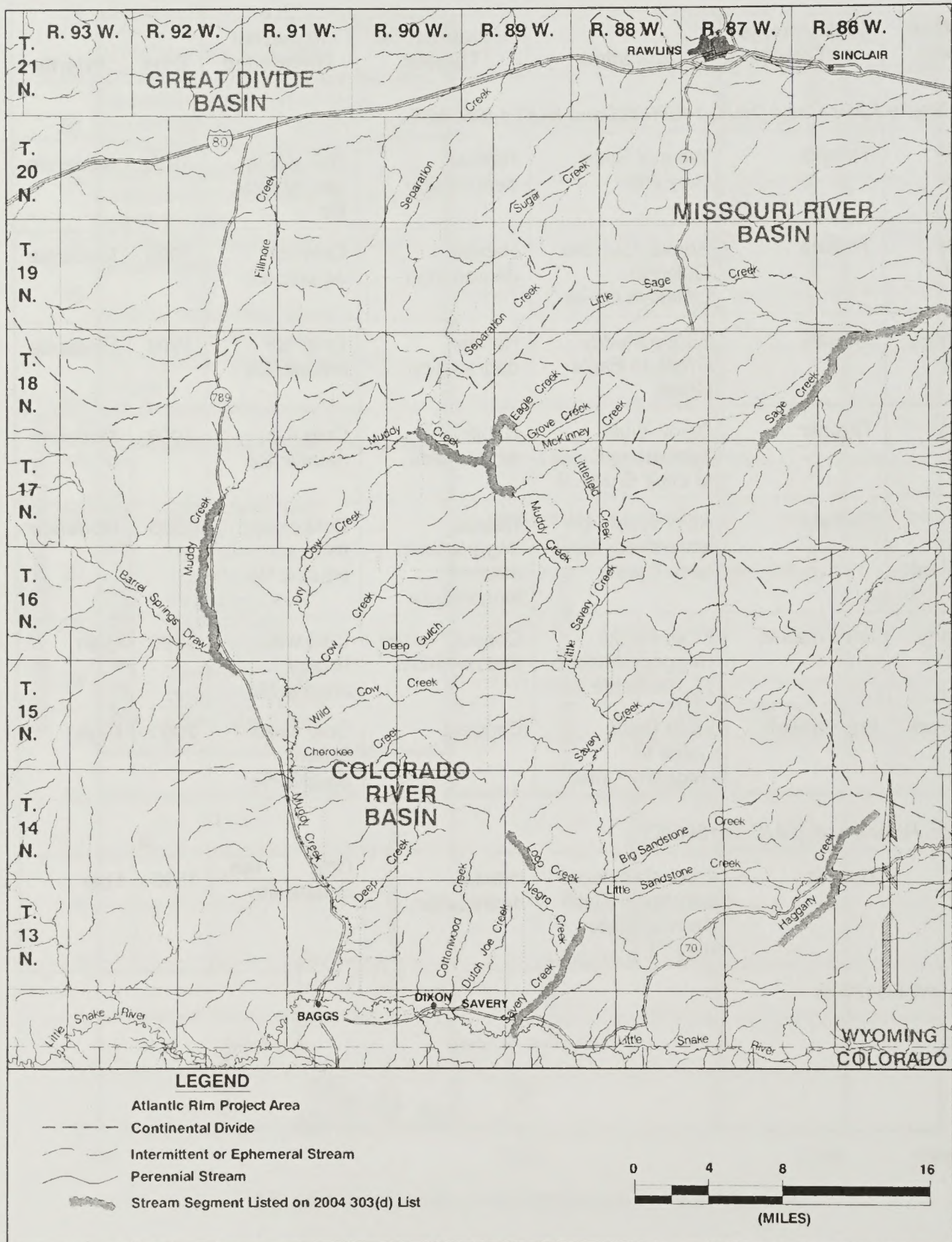
Table 3-21. 2006 303(d) Waterbodies with Impairments or Threats.

Surface Water	Impairments or Threats	Location	Impairments/ Threats	Use Impaired/ Threatened	Date	Priority
<i>Little Snake River Basin (HUC 14050003 and HUC 14050004)</i>						
Muddy Creek	Threats	West of State Hwy 789	Habitat degradation;	Non-game fish; aquatic life	1996	Moderate
Muddy Creek	Threats	Above Alamosa Gulch to Littlefield Creek	Habitat degradation	Cold fish; aquatic life	1996	Moderate
McKinney Creek	Threats	Above Muddy Creek to Eagle Creek	Habitat degradation	Cold fish, aquatic life	1996	Moderate
Savery Creek	Threats	Below Little Sandstone Creek to Little Snake R.	Habitat degradation	Cold fish, aquatic life	1998	Moderate
Loco Creek West Fork	Threats	All of West Fork watershed above Loco Creek	Habitat degradation; nutrients; temperature	Cold water fishery; aquatic life	1996	Moderate
Haggarty Creek	Impairments	From Ferris-Haggarty Mine to W. Fk. Battle Ck.	Copper, silver, and cadmium	Cold water fishery; aquatic life	1996	High
West Fork Battle Creek	Impairments	From Battle Creek to Haggarty Creek	Copper	Cold water fishery; aquatic life	2000	High
<i>Missouri River Basin (HUC 10180002)</i>						
Sage Creek	Threats	From confluence with North Platte River to State Hwy 71	Habitat degradation	Cold fish; aquatic life	1996	Low

Source: WDEQ (2006)

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-17. Threatened or Impaired Streams.



CHAPTER 3. AFFECTED ENVIRONMENT

According to WDEQ (2006), "Unstable stream channels and loss of riparian function have been a problem in much of the sub-basin," in reference to Muddy Creek (HUC 14050004). The LSRCD has been working in a Coordinated Resource Management process with the BLM, landowners, grazing permittees, WGFD, and other stakeholders since 1992 to address these water quality and riparian habitat problems. As part of the Coordinated Resource Management process, 319 watershed improvement projects have been completed in the Upper Muddy Creek drainage. Implementation measures include upland water development, cross fencing, vegetation management, and grazing while maintaining livestock numbers.

The upper portions of Muddy Creek and McKinney Creek to the confluence of Eagle Creek have been listed as having threats based on habitat degradation for non-game fish, coldwater fish, and aquatic life. Changes in upland runoff, hydrology, or increased sedimentation could reduce habitat for non-game fish, coldwater fish, and aquatic life. Habitat for these species includes pools and riffles. With increased sediment loads, riffles can become silted in and pools can fill, degrading the habitat. Changes in upland runoff conditions can increase peak flow conditions and may reduce base flows critical for maintaining late season pool habitats. Current road densities in these areas are less than 2 miles/mile², and accounts for a small amount of sediment delivery. Changes in grazing practices have generally improved vegetation conditions and improved rainfall/runoff conditions.

Other watershed restoration projects upstream of the ARPA have been implemented in the Grizzly Wildlife Habitat Management Area (WHMA), which includes the upper Littlefield Creek drainage and other portions of the upper Muddy Creek drainage. In the Grizzly WHMA, WGFD has been working with the BLM, the grazing permittee, and LSRCD to implement similar measures; however, the grazing strategy is to rest selected pastures to enable willow to better reestablish itself.

Water development projects have been implemented on the reach of Muddy Creek lying west of Highway 789 to address physical degradation of the stream channel, which threatens its aquatic life support. This reach of Muddy Creek is also on table C of the 303(d) list (WDEQ 2006). Implementation measures include wetland development, reestablishment of the floodplain, and irrigation water management. According to LSRCD, results of this project show an improving trend in riparian condition and bank stability above Red Wash.

However, habitat degradation has been identified by the BLM and LSRCD as a serious water quality concern on Muddy Creek, from Red Wash downstream to the Little Snake River. Habitat degradation is likely caused by season-long riparian grazing that is exacerbated by accelerated erosion associated with oil and gas activities. Several grazing management BMPs are being implemented in much of this lower watershed including changes in length, timing, and duration of grazing, and cross fencing. WDEQ states, "... projected increases in CBNG development have the potential to lead to increased surface disturbance and possible increased erosion and sediment loading" (WDEQ 2006).

In Savery Creek and West Fork Loco Creek, physical degradation of the stream channels is threatening full aquatic life support. The LSRCD is currently implementing a 319 watershed improvement project to address the threats. Portions of Haggarty Creek and West Fork Battle Creek, both east of the ARPA, are included on the 2006 303(d) list of impaired streams due to high copper, silver, and cadmium concentrations (WDEQ 2006). The sources of the metals have been identified as natural and from the Ferris-Haggarty Mine, which is located near the headwaters of Haggarty Creek.

CHAPTER 3. AFFECTED ENVIRONMENT

In the Upper North Platte River basin (HUC 10180002), the only stream currently listed as impaired or threatened is Sage Creek. According to the 2006 305(b) report, this creek has naturally high sediment load due to the erosive soils and arid climate in the watershed. A 319 watershed project was initiated in 1997 by the Saratoga-Encampment-Rawlins Conservation District in cooperation with the USDI-BLM, NRCS, WGFD, and landowners. The project has resulted in reduced sediment loading through a combination of short duration grazing, riparian and drifts fencing, upland water development, improved road management, grade control structures, and vegetation filtering.

WDEQ classifies Wyoming surface water resources according to quality and degree of protection. Table 3-16 summarizes the classification system based on acceptable uses. Table 3-17 lists the WDEQ classification of surface waters in the ARPA. The Little Snake River, Savery Creek, Sage Creek, and the North Platte River have been included with streams in the ARPA for comparison purposes.

3.4.4.3 Salinity Issues in the Colorado River Basin

The majority of the ARPA is located in the Colorado River Basin and, as such, point source discharge permits are regulated by the State of Wyoming in accordance with its adoption and incorporation into the Water Quality Rules and Regulations of the Colorado River Basin Salinity Control Forum, "Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program." As one of the seven member states of the forum, Wyoming permits point discharge sources of salinity in the Wyoming portion of the Colorado River Basin through its Wyoming Pollutant Discharge Elimination System permit program administered by the WDEQ-Water Quality Division (WQD) (CRBSCF 2005).

According to the Colorado River Basin Salinity Control Forum, the focus for the implementation of salinity standards in the National Pollutant Discharge Elimination System (NPDES) permit program policy is the following: "The objective for discharges shall be a no-salt return policy whenever practicable." The NPDES Program policy revised in 2002 allows for "freshwater waivers" and "offsets" for new industrial sources of salt in the Colorado River Basin. Fresh water waivers allow for the discharge of produced water when the maximum TDS concentration from all outfalls is less than 500 mg/L TDS. Offsets allow new industrial sources to be approved when another salt source is removed; for example, a flowing well that is shut-in. (See <http://www.coloradoriversalinity.org/2005%20Review%20October.pdf> for more information.)

3.4.4.4 Current Pod Conditions

The primary roads used to access the ARPA are U.S. Interstate Highway 80, State Highway (WY) 789, WY 70, and WY 71. A number of Carbon County and two-track roads provide access to and within the ARPA. Currently, there are approximately 1,000 miles of existing primary, secondary, and two-track roads within the ARPA (about 2.5 miles/mile²).

During the month of April 2005, a monitoring project was undertaken to evaluate the nine pods approved during the IDP (See appendix A). Pods were evaluated for quality of road construction, reclamation success, and general impacts related to surface hydrology. In general, the monitoring project found excessive erosion of disturbed areas related to inadequate road and pad design with regard to drainage features, damaged culverts or inadequately sized or placed culverts, lack of adequate maintenance, and areas with unsuccessful reclamation or

CHAPTER 3. AFFECTED ENVIRONMENT

weed infestations. It is important to keep in mind that the current pod conditions are expected to improve and that this is part of the existing environment.

3.4.4.5 Surface Discharge of Produced Water at the Cow Creek Pod

This project does not propose any surface discharge of produced water from non-federal leases into facilities on private land. It is therefore assumed that all water produced from the coal formation would be re-injected with the exception of offset uses for flowing wells, as described for Cow Creek. Surface discharge at the Cow Creek Pod can be expected to continue through the life of the project according to the WYPDES permits #WY0042145 and #WY0035858, which allow for 1.34 tons/day of salt and 180,600 gallons/day of total discharge (under both permits).

The surface discharge at the Cow Creek Pod is approved as an offset for an oil well (as defined by the Colorado River Salinity Control Forum) and the permit allows for the same volume of water and salt as was discharged by the oil well, prior to being plugged, (well number: 1x-12) into a reservoir on Dry Cow Creek. The discharge permit is currently being modified to allow water releases from the reservoir in a manner similar to historical operations from well 1x-12; however, volume restrictions would still be in place. The permit would have a new point of compliance upstream of the confluence with Cow Creek. This point of compliance would be monitored for flow. According to the permit, Cow Creek should only have water during storm events, that is, in response to natural precipitation and not as a result of project discharges.

3.4.5 Groundwater

The ARPA is located in the Colorado and Wyoming Basin groundwater regions described by Heath (1984), the Upper Colorado River Basin groundwater region described by Freethey (1987), or Washakie Basin described by Collentine et al. (1981) and Welder and McGreevy (1966). Groundwater resources include deep and shallow, confined and unconfined aquifers. Site-specific groundwater data for the ARPA are limited. Existing information comes primarily from oil and gas well records from the Wyoming Oil and Gas Conservation Commission, water-well records from the Wyoming SEO, from the USGS (Weigel 1987), from existing CBNG-producing wells, and from three monitoring wells drilled to monitor pressures in producing coals and sandstone zones above and below the target coals.

Regional aquifer systems pertinent to the ARPA are discussed by Heath (1984), Freethey (1987), and Driver et al. (1984). Basin-wide evaluations of hydrogeology specific to the ARPA have been investigated by Collentine et al. (1981). The most relevant hydrogeologic study specific to the ARPA is by Welder and McGreevy (1966).

3.4.5.1 Groundwater Location and Quantity

Groundwater in the Washakie Basin is generally found in deep artesian aquifers; in unconfined Tertiary deposits; alluvial deposits; and locally, where saturated rocks are near the surface (Welder and McGreevy 1966). Table 3-22 summarizes the water-bearing characteristics of the geologic formations present in the vicinity of the project. Of the geologic units listed in the table, Welder and McGreevy (1966) suggest that those capable of producing the greatest quantity of water include the following: Quaternary alluvium; Tertiary deposits in the North Park, Browns Park, Wasatch, and Fort Union Formations; Cretaceous formations, including Mesaverde, Frontier, and Cloverly; the Sundance-Nugget Sandstone of the Jurassic Age; and the Tensleep and Madison Formations of the Paleozoic Era.

CHAPTER 3. AFFECTED ENVIRONMENT

A brief description of the major aquifers of the ARPA is provided below.

- Quaternary aquifers in the Washakie Basin consist of alluvial deposits along major floodplains; isolated, windblown segments; and lake sediments. The major Quaternary aquifers in the vicinity of the ARPA occur in alluvial deposits along the Little Snake River and Muddy Creek and in windblown segments along the Sand Hills. Groundwater flow within the sandy Quaternary aquifers is typically downward towards permeable underlying formations (Collentine et al. 1981). Ephemeral and intermittent drainages often contain groundwater in the associated unconsolidated valley fills. Incised drainages serve as capture areas for eolian sand in reaches perpendicular with the prevailing winds. The sand-choked drainages favor rapid infiltration of rainfall and snowmelt leading to contact springs and seeps where groundwater perched in sandy surficial deposits escapes along contacts with less permeable bedrock.
- Tertiary aquifers in the ARPA occur in the extensive North Park Formation east of the ARPA, the Browns Park Formation along the Little Snake River floodplain and adjacent to the Sierra Madre Uplift, the Fort Union Formation near the Muddy Creek floodplain to the west, and isolated Wasatch Formation outcrops in the center of the ARPA. Aquifers near the surface are recharged from direct downward percolation of precipitation and snowmelt and from seepage losses from streams. Deep aquifers are also recharged by these processes in outcrop and subcrop areas and from slow leakage from overlying and underlying aquifers. The extent of the Browns Park and North Park units above the eroded, dipping Cretaceous units indicates a probable significant recharge area of the underlying permeable units of the Mesaverde Group.

The proposed CBNG development is targeted principally at coalbeds contained in the Almond Formation member located within the upper portions of the late Cretaceous Mesaverde Group. The terrestrial, sandy, marginal marine Almond Formation is composed of a wide variety of heterogeneous rock types. Single, thick, widespread aquifers having uniform porosity and permeability characteristics are probably not present (Welder and McGreevy 1966).

Individual coalbeds may persist for thousands of feet laterally and may be in close contact with overlying and underlying sandstones. Pressure data from three monitoring wells installed in the ARPA as part of the IDP program indicates that pressures in the sandstones adjacent to the coalbeds are declining along with pressure in the coalbeds (table 3-23). This indicates that the adjacent sandstones within the Mesaverde Group are in hydraulic communication with the coalbeds and are being dewatered by removal of water from the coals.

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-22. Water-bearing Characteristics of Geologic Formations in the Washakie Basin.

Era	Period	Geologic Unit	Thickness	Hydrologic Properties		
				Well Yield (gpm)	Transmissivity (gpd/ft)	Permeability (gpd/ft ²)
Cenozoic	Quaternary		0-70	<30	168-560	21-62
		North Park Fm.				
	Tertiary	Browns Park Fm.	0-1,200	3-30	100-10,000	NM
		Wasatch Fm.	0-4,000+	30-50	150-10,000	0.04-18.2
		Fort Union Fm.	0-2,700+	3-300	<2,500	<1
Mesozoic	Upper Cretaceous	Lance Fm.	0-4,500+	<25	<20	0.007-8.2
		Fox Hills Sandstone	0-400	NM	10-20	0.9
		Lewis Shale	0-2,700+	2-252	0.03-50	0.002-0.9
		Almond Fm. (Mesaverde Group)	0-600	NM	2,000-8,000 ¹	100-800 ¹
		Mesaverde Group (excl. Almond Fm.)	300-2,800	<100	<3,000	NM
		Baxter Shale (incl. Steele Shale and Niobrara Fm.)	2,000-5,000+	Major regional aquitard between Mesaverde and Frontier aquifers. Hydrologic data unavailable.		
		Frontier Fm.	190-1,1900+	1-100+	<100-6,500	NM
	Lower Cretaceous	Mowry Shale	150-525	Regional aquitard. Hydrologic data unavailable.		
		Thermopolis Shale (incl. Muddy Sandstone)	20-235	Considered a leaking confining unit. Hydrologic data unavailable.		
		Cloverly Fm.	45-240	25-120	340-1,700	1-177
	Upper Jurassic	Morrison Fm.	170-450+	Confining unit between Cloverly and Sundance-Nugget aquifers. Hydrologic data unavailable.		
		Sundance Fm.	130-450+	27-35	12-3,500	NM
	Lower Jurassic-Upper Triassic	Nugget Sandstone	0-650+	35-200	<2,166	NM
	Triassic	Chugwater Fm.	900-1,500+	Confining unit between Sundance-Nugget and Paleozoic aquifers. Hydrologic data unavailable.		
Mesozoic-Paleozoic	Lower Triassic Permian	Phosphoria Fm. (incl. Goose Egg Fm.)	170-460	Probable poor water-bearing capabilities due to low permeability. Hydrologic data unavailable.		
Paleozoic	Permian-Pennsylvanian	Tensleep Fm.	0-840+	24-400	1-374	NM
	Lower and Middle Pennsylvanian	Amsden Fm.	2-260+	Probable poor water-bearing capabilities due to predominance of fine-grained sediments.		
	Mississippian	Madison Limestone	5-325+	<400	Variable	NM
Paleozoic	Cambrian	Indef. rocks	0-800+	4-250	NM	NM
Precambrian	N/A	Igneous and metamorphic rocks	Unknown	10-20	1<1,000	Generally high in upper 200 ft of unit

Notes:

Adapted from Table V-1 in Collentine et al. (1981). Formations not encountered in ARPA have been omitted.

¹ From Atlantic Rim CBNG well test data.

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-23. Pressure Data from Atlantic Rim Groundwater Monitoring Wells.

Pod Name	Location	Well No.	Formation	Beginning Date	Beginning Pressure (psi)	Ending Date	Ending Pressure (psi)	Change in Pressure (psi)
Sun Dog	16N 91W Sec 17	1691-M17	Sand Above Coals	04/05/05	443	08/14/06	414	29
			Coals	04/05/05	496	08/14/06	455	41
			Sand Below Coals	04/05/05	753	08/14/06	740	13
Brown Cow	14N 92W Sec 12	12-12-1491	Sand Above Coals	06/07/06	446	08/14/06	436	10
			Coals	06/07/06	526	08/14/06	499	27
			Sand Below Coals	06/07/06	750	08/14/06	749	1
Jolly Roger	18N 90W Sec 5	1890 14-5M	Sand Above Coals	05/03/06	163	08/18/06	163	0
			Coals	05/03/06	148	08/18/06	148	0
			Sand Below Coals	05/03/06	119	08/18/06	119	0

Notes:

Jolly Roger does not change in pressure because of the short period of pumping.

Brown Cow has a short period of record, but there has been wells pumping there for several years.

The Sandstone layer below the coals tends to have more of a delayed reaction.

Groundwater generally flows west-southwest from the higher elevations along the Sierra Madre Uplift toward the low-lying Washakie Basin center and the major streams (Collentine et al. 1981). A number of generally east-west to northeast-southwest trending normal faults have been recognized in upper Cretaceous and Lower Tertiary rocks. Although the displacements along these faults are probably less than 50 feet, the coalbeds are less than 20 feet thick; therefore, the faulting can create flow boundaries or conduits for upward and/or downward leakage of groundwater. Fault zones filled with clay or that have become sealed with silica or other minerals may be practically impermeable; whereas, those filled with crushed rock fragments can be extremely permeable. Some faults permit groundwater to circulate to great depths where it can become heated by geothermal heat sources (Groundwater Atlas [HA730-I]).

The Sundance-Nugget aquifer of the Jurassic Age is separated from the upper Cretaceous aquifers by the impermeable Morrison Formation. The Sundance-Nugget aquifer consists of permeable sandstone with minor quantities of shale, siltstone, and limestone (Collentine et al. 1981). The flow characteristics of the Sundance-Nugget aquifer are not well defined.

The final two major aquifers occur in Paleozoic Era rocks. The Tensleep Formation from the Pennsylvania Age consists of fine- to medium-grained sandstone between confining layers of the Chugwater Formation (Triassic) and the Amsden Formation (Pennsylvanian) (Collentine et al. 1981). The Madison aquifer consists of limestone and dolomite bordered on the top by the fine-grained Amsden Formation sediments and on the bottom by Cambrian rocks. Early Paleozoic rocks are notably absent from far southeast Wyoming and extremely thin on the west flank of the Sierra Madre uplift east of the ARPA. The zero isopach line for these Paleozoic units lies across and north of the Sierra Madre uplift indicating either non-deposition or erosion and complete removal of these units across the ancestral uplift prior to deposition of Mesozoic and Cenozoic rocks. The truncated edge of the Cambrian and Mississippian rocks lies

CHAPTER 3. AFFECTED ENVIRONMENT

immediately east of the ARPA according to Blackstone (1963). Wells completed within both of these Paleozoic aquifers, where present and of significant thickness, have demonstrated yields up to 400 gallons per minute (gpm).

Driver et al. (1984) suggest that the Browns Park Formation would be the best candidate for large-scale groundwater development. Recharge to the aquifer is generally by precipitation and surface water seepage percolating through permeable overlying materials (Welder and McGreevy 1966). The major discharge channels, evaporation, and seepage to surface water generally offset the recharge such that groundwater levels are relatively stable (Welder and McGreevy 1966).

An SEO records review revealed 90 permitted non-CBNG wells and springs in the ARPA. Nine of the water rights are filed on springs. They are apportioned as follows: two domestic, six domestic/stock, 52 stock, one stock/irrigation, two stock/miscellaneous, one industrial, and 26 monitoring wells. Of the 90 permitted wells and springs, 58 reported positive yields. Geologic units and yields of the 58 wells are listed in table 3-24. The majority of these wells were developed in the upper Mesaverde Group, the Lewis Shale, and the Browns Park Formation.

Table 3-24. Existing Groundwater Wells in ARPA Vicinity.

Formation	Number of Wells	Yield ¹ (gpm)
Browns Park Formation	12	1–25
Fort Union Formation	1	11
Lance Formation	6	1–25
Fox Hills Sandstone	2	10–15
Lewis Shale	12	3–25
Mesaverde Group	25	1–500

Note:

¹ Obtained from Wyoming State Engineer's Office well completion permits

3.4.5.2 Groundwater Quality

Groundwater quality is related to the depth of the aquifers, flow between aquifers, rock type, and length of time groundwater is in contact with the enclosing rock type. Dissolved mineral content generally increases with time. Circulation in deeply buried aquifers is generally sluggish; as such, many confined aquifers contain slightly saline to very saline water at depth. Groundwater quality is variable in the ARPA. TDS, an indicator of salinity, is generally less than 2,000 mg/L (slightly saline to saline), with occasional local concentrations of less than 500 mg/L (considered fresh) and more than 7,000 mg/L (Red Rim Pod). Elevated TDS is caused by a variety of factors including evapotranspiration, mixing of adjacent aquifers, the presence of soluble material, and restriction of flow by faults or impermeable formations.

Because most existing groundwater wells and the proposed CBNG wells of the Atlantic Rim project occur in Mesaverde aquifers, a detailed Mesaverde groundwater quality analysis has been included. Table 3-25 lists the major ionic composition of Mesaverde groundwater in the ARPA. Sodium and bicarbonate dominate as the major ionic species. Collentine et al. (1981) offer three possible explanations for this dominance: (1) exchange of dissolved calcium for

CHAPTER 3. AFFECTED ENVIRONMENT

sodium; (2) sulfate reduction resulting in bicarbonate generation; and (3) intermixing of sodium-rich, saline water from low-permeability zones within the Mesaverde or adjacent aquifers.

Table 3-25. Major Ionic Composition of Mesaverde Groundwater.

Cation	Concentration (mg/L)	Anion	Concentration (mg/L)
Sodium	513	Bicarbonate ²	1,284
Calcium	7	Carbonate ¹	9
Magnesium	3	Chloride	56
Potassium ¹	5	Sulfate	11

Notes:

¹ Potassium and carbonate concentrations were not measured in CBNG samples; values represent composite of USGS data for Mesaverde wells in project vicinity (USGS 1980).

² Bicarbonate was not measured; value shown was calculated from ion balance.

In addition to conventional inorganic analysis, isotopic analysis has been performed on groundwater collected from numerous wells constructed within the interim drilling pods. Groundwater samples from eight CBNG wells were analyzed for tritium, a radioactive isotope of hydrogen, and deuterium and ¹⁸O stable isotopes of hydrogen and oxygen. The absence of tritium in groundwater is indicative of water that was isolated from the atmosphere before the early 1950s when large amounts of tritium were introduced into the environment through testing of nuclear devices in the atmosphere (Faure 1986). The tritium content of the eight samples indicates pre-1950s recharge. Further, the isotopic ratios of ¹⁸O and deuterium indicate that the groundwater was isolated from the atmosphere when the mean temperature was approximately 10 degrees cooler than the present. Since temperatures this low are associated with the Pleistocene Epoch, which ended approximately 10,000 years ago, this information suggests that groundwater flow through the Mesaverde Group coals is sluggish and apparently not closely connected to nearby surface water supplies. A Local Meteoric Water Line (LMWL) should be developed from isotopic samples of surface waters to confirm this hypothesis (See section 4.4.5). Table 3-26 presents the results of isotope analysis.

Table 3-26. Isotopic Analysis of Mesaverde Group Coal bed Groundwater.

Well	Tritium Content (TU)	$\delta^{18}\text{O}_{\text{smow}}$ (‰)	$\delta\text{D}_{\text{smow}}$ (‰)
Fed. 1691-16-8	<0.34	-19.32	-145.5
AR Fee 1791 231 Haystack Mtns	<0.50	-19.70	-148.4
AR Fee 1791 231 Deep Creek	<0.60	-19.60	-145.8
AR Fee 1791 231 Cherokee Creek	<0.60	-19.49	-146.7
AR Fee 1791 3-23	<0.50	-18.85	-141.7
AR Federal 1591 9I	<0.50	-19.39	-144.4
AR Fee 1890 SE9	<0.50	-19.74	-148.5
AR Federal 1591-7-8 Blue Sky	<0.60	-19.20	-142.9

Notes:

T.U. - Tritium Unit. One TU is defined as one tritium atom per 1,018 hydrogen atoms.

SMOW - an international standard used for oxygen and hydrogen isotopic analysis.

0/00 is per million or per thousand

Table 3-27 presents a comparison of Mesaverde groundwater with WDEQ-use-suitability standards. The composite results of samples collected from the three CBNG wells indicated water that is generally suitable for livestock use, but is unsuitable for domestic supply or irrigation without treatment or dilution. Parameters with measured concentrations in excess of

CHAPTER 3. AFFECTED ENVIRONMENT

Wyoming drinking water standards included iron, manganese, and TDS. Calculated SAR (47.3) and residual sodium carbonate (41 milliequivalents per liter [meq/L]) exceeded the agriculture suitability limits of 8 and 1.25, respectively. Unless the water was mixed with an existing water source of lower sodium and bicarbonate and lower total salinity, irrigation could result in reduction in infiltration in the affected soil.

Table 3-27. Groundwater Quality for Mesaverde Wells in the ARPA.

Parameter	Concentration ¹	Unit	Groundwater Suitability Standards ²		
			Domestic	Agriculture	Livestock
Aluminum	0.045	mg/l	---	5	5
Ammonia	0.9	mg/l	0.5	---	---
Arsenic	0.0006	mg/l	0.05	0.1	0.2
Barium	0.36	mg/l	1	---	---
Beryllium	<0.002	mg/l	---	0.1	---
Boron	0.25	mg/l	0.75	0.75	5
Cadmium	<0.0002	mg/l	0.01	0.01	0.05
Chloride	56	mg/l	250	100	2000
Chromium	0.002	mg/l	0.05	0.1	0.05
Cobalt	NM	mg/l	---	0.05	1
Copper	0.03	mg/l	1	0.2	0.5
Cyanide	<5	mg/l	0.2	---	---
Fluoride	1.0	mg/l	1.4 - 2.4	---	---
Hydrogen Sulfide	NM	mg/l	0.05	---	---
Iron	3.06	mg/l	0.3	5	---
Lead	0.004	mg/l	0.05	5	0.1
Lithium	NM	mg/l	---	2.5	---
Manganese	0.102	mg/l	0.05	0.2	---
Mercury	<0.0004	mg/l	0.002	---	0.00005
Nickel	0.041	mg/l	---	0.2	---
Nitrate	<0.03	mg/l	10	---	---
Nitrite	<0.03	mg/l	1	---	10
Oil & Grease ³	<1	mg/l	Virtually Free	10	10
Phenol	65	mg/l	0.001	---	---
Selenium	<0.005	mg/l	0.01	0.02	0.05
Silver	<0.003	mg/l	0.05	---	---
Sulfate	11	mg/l	250	200	3000
TDS	1,322	mg/l	500	2000	5000
Uranium	NM	mg/l	5	5	5
Vanadium	NM	mg/l	---	0.1	0.1
Zinc	0.3	mg/l	5	2	25
pH	8.2	s.u.	6.5 - 9.0	4.5 - 9.0	6.5 - 8.5
SAR	47.3	<none>	---	8	---
RSC ⁴	41	meq/L	---	1.25	---
Radium 226 + Radium 228	0.9	pCi/l	5	5	5
Strontium 90	NM	pCi/l	8	8	8
Gross alpha	NM	pCi/l	15	15	15

Notes:

¹ Boron, ammonia, fluoride, and nitrate/nitrite concentrations from 11 Mesaverde groundwater wells (USGS, 1980); remaining concentrations from three Mesaverde CBNG wells in the ARPA.

² From WDEQ Water Quality Rules and Regulations, Chapter VIII.

³ Reported as total petroleum hydrocarbons.

⁴ Residual sodium carbonate calculated from measured calcium and magnesium concentrations and calculated bicarbonate concentration.

CHAPTER 3. AFFECTED ENVIRONMENT

The confining beds slow the vertical movement of water, and so the movement of potential contaminants between aquifers. Although there is some downward movement of the water from the surface units, most of the groundwater movement, if any, is upward from the deeper aquifers to the shallower aquifers.

3.4.5.3 Springs and Flowing Wells

The project area contains numerous springs and flowing wells, which are important local water sources for livestock and wildlife. This area has had extensive exploratory development for natural gas and oil. Monitoring wells have been installed by the USGS to evaluate groundwater resources and also by private firms to evaluate potential coal mining (HSI 1981).

Springs in the ARPA occur at two distinct geologic horizons; at the contact between the Tertiary Browns Park Formation and the underlying Upper Cretaceous Mesaverde Group, and within the Mesaverde Group itself. The waters from the two spring types have distinctly different chemical signatures: water from the Browns Park Formation springs is low in TDS, enriched in silica, and of the calcium bicarbonate type, while water from the Mesaverde Group springs is higher in TDS, with lower silica concentrations, and of the calcium sulfate type. Table 3-28 presents a comparison of the two water types. Map M-18 depicts the locations of the springs that were sampled to create table 3-28. Based on water rights information available from the SEO, four of the sampled springs (S-2, S-3, S-4, and S-7) may possess valid water rights.

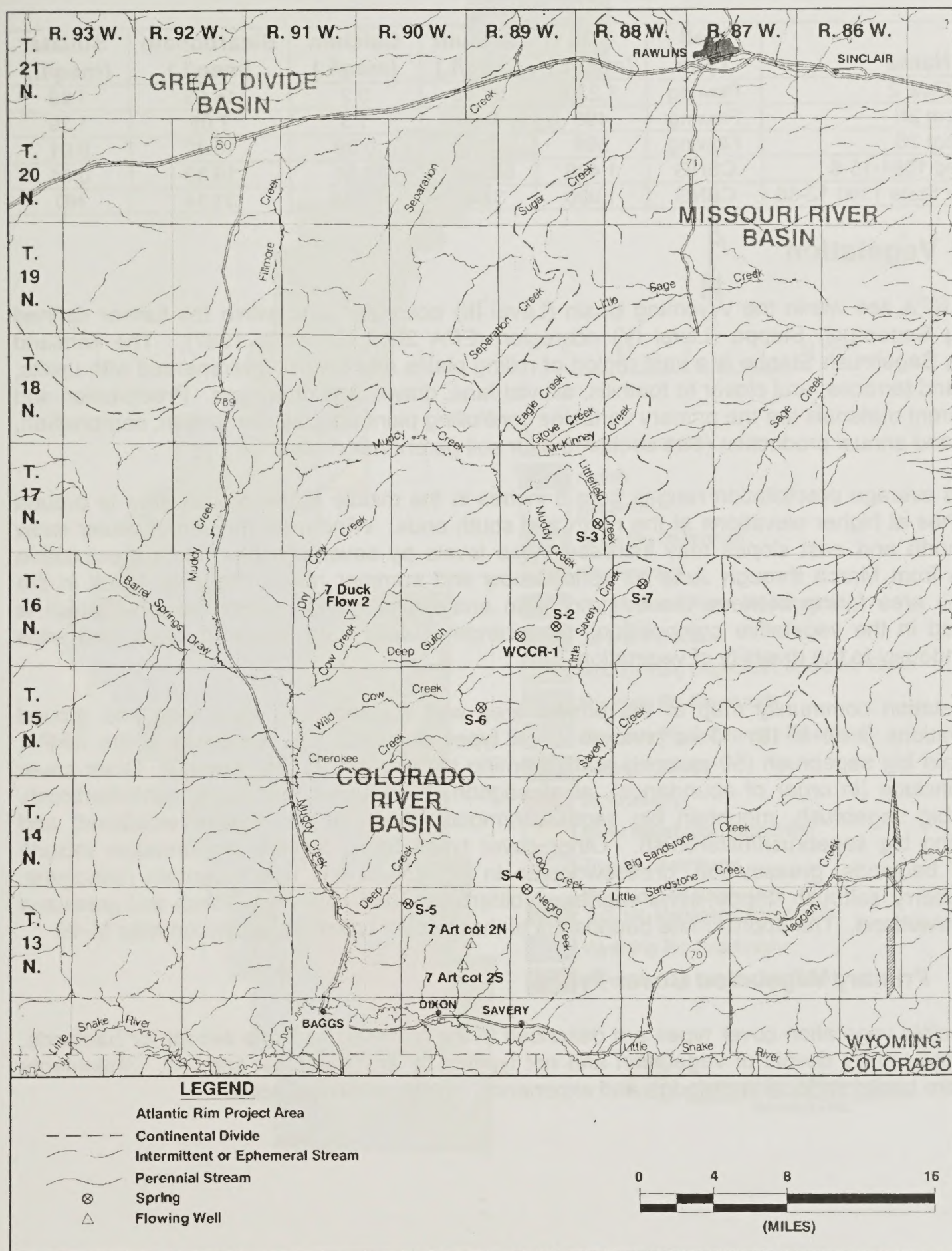
Table 3-28. Comparison of Selected Water Quality Parameters between Springs of the Browns Park Formation and the Mesaverde Group.

Spring Name	Geology	TDS (mg/l)	Silica (mg/l)	Water Type
S-2	Browns Park	330	18.1	Calcium bicarbonate
S-3	Browns Park	210	14.9	Calcium bicarbonate
S-4	Browns Park	290	11.0	Calcium bicarbonate
S-7	Browns Park	329	18.0	Calcium bicarbonate
WWCR-1	Mesaverde	1,030	8.1	Calcium sulfate
S-5	Mesaverde	1,350	5.8	Calcium sulfate
S-6	Mesaverde	1,140	5.4	Calcium sulfate

At least 16 flowing wells in the project area have been developed to supply water to wetland areas and stock watering facilities. The chemistry of water sampled from at least one of the flowing wells in the ARPA (Duck Flow 2 well, See table 3-29) indicates that the groundwater may be from the Almond Formation coalbeds. Many of these flowing wells are abandoned exploratory oil or gas wells drilled in the 1950s or 60s that produce methane gas along with water. Since methane is commonly associated with coalbeds, it is likely that some of these flowing wells have casing failures adjacent to Almond Formation coalbeds. Groundwater associated with methane production is rich in the anion bicarbonate and almost devoid of the cations calcium and magnesium, but exhibit high concentrations of sodium (Van Voast 2003). Table 3-29 compares water quality parameters from the flowing wells and that from wells completed in the Almond Formation coal seams. The locations of the flowing wells are depicted on map M-18.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-18. Sampled Springs and Flowing Wells.



CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-29. Comparison of Selected Water Quality Parameters in Flowing Wells and Wells Completed in the Almond Formation Coal Seam.

Well Name	Well Type	TDS (meq/L)	Sodium (meq/L)	Calcium (meq/L)	Bicarbonate (meq/L)	Sulfate (meq/L)
Duck Flow 2	Flowing	1,230	22.18	0.2	18.03	1.29
7 Art cot 2N	Flowing	496	6.96	1.3	7.05	1.39
7 Art cot 2S	Flowing	596	12.18	0.09	10.32	0.01
AR Fed 1691-16-8	CBNG	1,428	23.4	0.34	19.83	0.04
S & W State 1390 12-36	CBNG	1,900	32.49	0.046	31.14	ND

3.5 Vegetation

The ARPA lies within the Wyoming Basin (Level III) ecoregion and within the further defined Rolling Sagebrush Steppe (Level IV) ecoregion (EPA 2002, Omernik 1987). The semiarid Rolling Sagebrush Steppe is a vast region of rolling plains and basins; interspersed with uplifts, rims, and terraces; and closer to foothills, alluvial fans, draws, and drainages. Precipitation and soil parent materials are the primary variables controlling plant species distribution, composition, cover and annual production (See section 3.3 for soil parent materials).

Annual average precipitation ranges from 8 inches in the middle of the project area to around 12 inches at higher elevations at the north and south ends. Wind redistribution of winter snow onto north and east slopes may increase these levels by several inches. Most precipitation occurs from March through June as spring snow and summer rain. These all result in the Rawlins area falling between the Intermountain and Great Plains ecotone regions, which is reflected in the vegetative composition. The range in soils from sands to clays also adds tremendously to the diversity of vegetation.

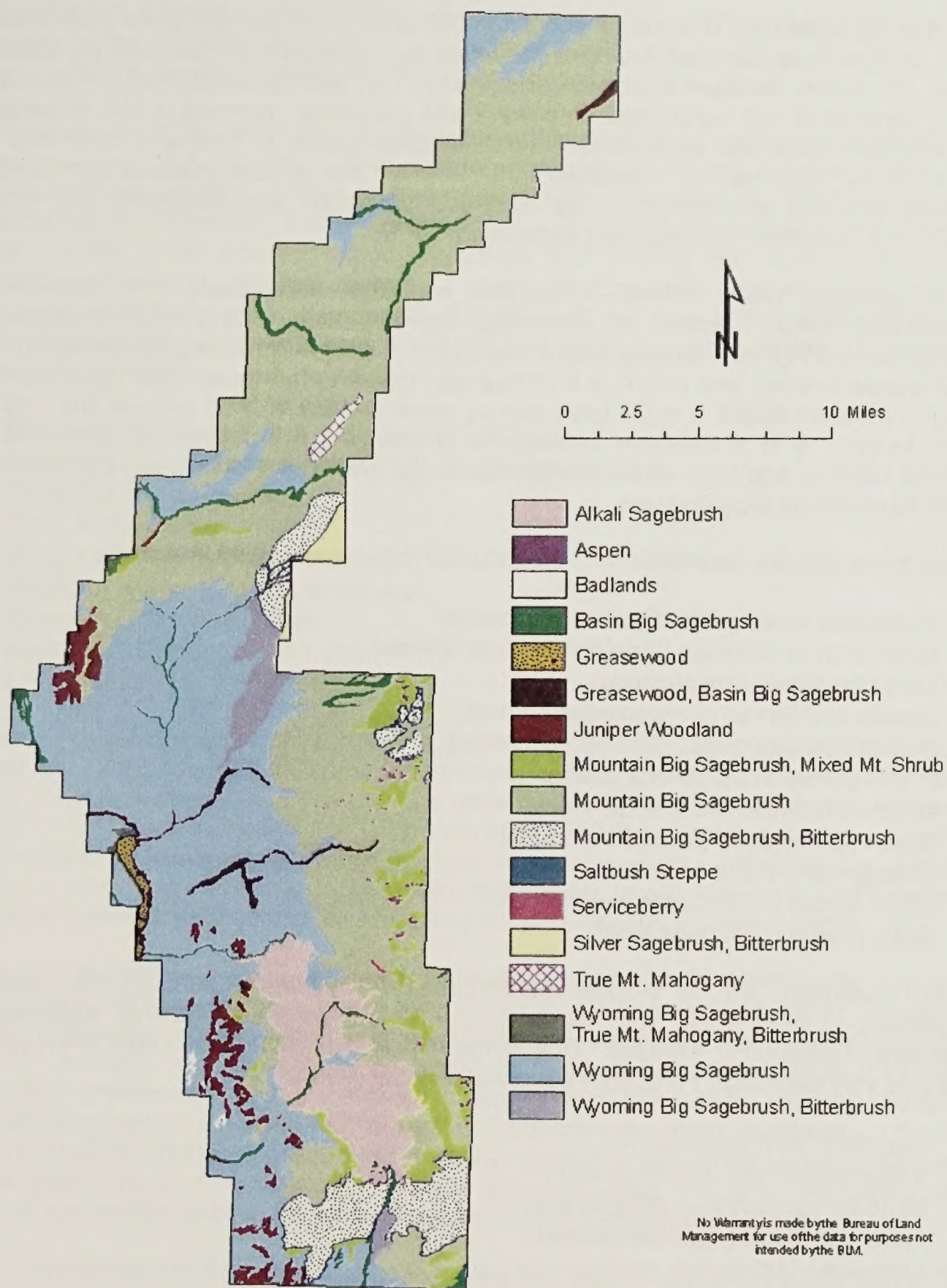
A vegetation community map of the project area was created from local data and ground observations (map M-19). Two principle cover types dominate the vegetation in the ARPA, mountain big sagebrush (50 percent) and Wyoming big sagebrush (34 percent). Other cover types include (in order of abundance): alkali sagebrush, mountain big sagebrush/bitterbrush, basin big sagebrush, mountain big sagebrush/mountain shrub mix, juniper woodland, and Wyoming big sagebrush/bitterbrush. Other cover types found in very low amounts include aspen, badlands, greasewood, greasewood/basin big sagebrush, true mountain mahogany, serviceberry, saltbush steppe, silver sagebrush/bitterbrush, and willow-waterbirch and grassland riparian/wetland. The approximate boundaries of these cover types are shown on map M-19.

3.5.1 Primary Vegetation Cover Types

All principle vegetation cover types are described in the following sections except for badlands, which are mostly devoid of vegetation and not typified by any particular species. Statements made are based on local knowledge and experience, unless otherwise noted.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-19. Vegetation Communities.



CHAPTER 3. AFFECTED ENVIRONMENT

3.5.1.1 Mountain Big Sagebrush Cover Type and Subtype Inclusions

This type of big sagebrush is found on about 136,000 acres or 50 percent of the project area. In the past, studies have identified *Artemisia tridentata* spp. *vaseyana* as mountain big sagebrush. However, the newer literature (Goodrich et al. 1999, Tart and Winward 1996) recognizes two separate varieties of this subspecies, *vaseyana* and *pauciflora*. Numerous field investigations have found that these two varieties are morphologically similar in form and commonly found intermixed in the same habitat. Therefore, in the ARPA it has all been mapped as mountain big sagebrush, and will be referred to as *Artemisia tridentata* ssp. *vaseyana* and *Artemisia tridentata* ssp. *pauciflora* (mountain big sagebrush) (ATVII).

ATVII is generally found around 7,000 feet and higher elevations. It appears as a multi-branched shrub, similar to Wyoming big sagebrush (*Artemisia tridentata* spp. *Wyomingensis* [ATW]), with varying height and cover. On wind-blown ridges with shallow soils, ATVII is sparse in cover and only 6 to 8 inches tall. However, on moderately deep loamy soils with higher moisture levels, it might have canopy cover in excess of 50 percent and may reach 3 feet in height. It is a palatable species for browsing, but it is typically only used on a transitional basis to and from winter habitat due to the elevation it occurs at, and often shows only light to moderate browsing use.

Common grass species associated with the mountain big sagebrush type include:

- Thickspike wheatgrass (*Elymus macrourus*),
- Bluebunch wheatgrass (*Pseudoroegneria spicata*),
- Little bluegrass (*Poa secunda*),
- Needle-and-thread (*Hesperostipa comata*),
- Bottlebrush Squirreltail (*Elymus elymoides*),
- Prairie Junegrass (*Koeleria cristata*),
- Mutton bluegrass (*Poa fendleriana*),
- Green needlegrass (*Nassella viridula*),
- Oniongrass (*Melica bulbosa*),
- Idaho fescue (*Festuca idahoensis*), and
- Spike fescue (*Leucopoa kingii*).

Common understory shrubs include rabbitbrushes (*Chrysothamnus* spp.) and snowberry (*Symphoricarpos oreophilus*), with lesser amounts of bitterbrush (*Purshia tridentata*) and serviceberry (*Amelanchier alnifolia*). Due to the higher precipitation on these sites, forbs are diverse and very abundant. Frequently observed species include:

- Bluebells (*Mertensia* spp.),
- Indian paintbrush (*Castilleja* spp.),
- Sego lily (*Calochortus nuttallianum*),
- False dandelion (*Agoseris glauca*),
- Locoweed (*Astragalus* spp.),
- Buttercup (*Ranunculus* spp.),
- Wild onion (*Allium* spp.),
- Beardtongue (*Penstemon* spp.),
- Groundsel (*Senecio* spp.),
- Phlox (*Phlox multiflora*),

CHAPTER 3. AFFECTED ENVIRONMENT

- Sulfur buckwheat (*Eriogonum umbellatum*),
- Geranium (*Geranium richardsonii*),
- silky lupine (*Lupinus sericeus*),
- arrowleaf balsamroot (*Balsamorhiza sagittata*),

ATVII/mountain shrub mix cover type is similar to the Mountain Big Sagebrush described above, with the distinction that mountain shrub species comprise 5 percent or more of the canopy cover. It comprises about 6 percent of the project area or approximately 15,000 acres. In the area bordering the sandhills, the mountain shrub component is dominated by bitterbrush. However, on the south sides of Muddy Mountain and Browns Hill, there is a mixture of bitterbrush, serviceberry, and snowberry; on rocky, shallow soils, true mountain mahogany (*Cercocarpus montanus*) can also be found. On the north and east slopes of Muddy Mountain, where snow deposition occurs, sites are moister and support a wider variety of species than described above including:

- Chokecherry (*Prunus virginiana*) in the overstory,
- Scattered aspen (*Populus tremuloides*) in the overstory,
- Elk sedge (*Carex geyeri*),
- Ross' sedge (*Carex rossii*),
- Black sagebrush (*Artemisia nova*),
- Mountain brome (*Bromus anomalus*),
- Elkweed (*Frasera speciosa*),
- Bedstraw (*Galium boreale*), and
- Oregon grape (*Berberis repens*).

These sites are important to a wide variety of wildlife for the habitat they provide, but particularly as forage and hiding cover for mule deer and as forage, nesting and brood rearing, and roosting areas for Columbian sharp-tailed grouse. The more moist sites are not as prone to burn as drier sites, but the fuel loads in these communities will burn in wildfires or prescribed burns under the right conditions. Recovery by most species is usually good, especially by snowberry, chokecherry, and true mountain mahogany. But bitterbrush, and to a lesser extent serviceberry, can be more susceptible to death loss when fires occur during the summer months.

Wildfires and prescribed burns both occur in the ATVII cover type. Without rest or post-burn grazing management, sagebrush cover may return to pre-treatment levels in twenty years. However, monitoring of prescribed burns with rest or deferment after treatment indicates sagebrush recovery may take up to 50 years to reach pre-treatment levels. Under this management, grasses and forbs are allowed to dominate the site initially, reducing the ability of sagebrush seedlings to establish themselves and out-compete other vegetation. The higher amount of moisture on these sites increases their productivity. Response to reclamation should be good (most previous reclamation efforts in this type have not been successful due to insufficient reclamation techniques compounded with recent drought conditions).

3.5.1.2 Wyoming Big Sagebrush and Wyoming Big Sagebrush/Bitterbrush Cover Types

Wyoming big sagebrush ATW is the shortest subspecies of big sagebrush, but ecologically perhaps the most important. It occupies the more arid environments, generally below 7,000 feet, and provides critical habitat and forage for species like pronghorn antelope and greater sage-grouse. ATW is second only to ATVII in abundance, occupying about 92,300 acres or 34 percent of the project area. Small inclusions of basin big sagebrush, saltbush steppe, and

CHAPTER 3. AFFECTED ENVIRONMENT

greasewood occur within approximately 5 percent of this area. The height of ATW varies from a few inches tall to over 2 feet, with more vigorous and denser stands occurring in swales with deeper soils and more precipitation. On open, wind-blown sites, which normally have a shallower effective rooting depth, ATW is sparser, smaller in stature, and exhibits lower productivity.

The most common grasses associated with ATW cover type are:

- Western wheatgrass (*Pascopyrum smithii*),
- Thickspike wheatgrass,
- Little bluegrass,
- Bottlebrush squirreltail,
- Needle-and-thread,
- Indian ricegrass (*Achnatherum hymenoides*), and
- Threadleaf sedge (*Carex filifolia*).

Common understory shrubs include:

- Douglas rabbitbrush (*Chrysothamnus viscidiflorus*),
- Rubber rabbitbrush (*C. nauseosus*),
- Winterfat (*Krascheninnikovia lanata*),
- Cotton horsebrush (*Tetradymia canescens*),
- Prickly-pear cactus (*Opuntia polyacantha*), and
- Broom snakeweed (*Gutierrezia sarothrae*).

Forbs are less common than in other big sagebrush communities due to the more arid conditions. However, the most frequently observed species include:

- Hood's phlox (*Phlox hoodii*),
- Hooker sandwort (*Arenaria hookeri*),
- Low buckwheat (*Eriogonum ovalifolium*),
- Spring parsley (*Cymopterus acaulis*),
- Locoweeds,
- Goldenweed (*Happlopappus* spp.),
- Hollyleaf clover (*Trifolium gymnocarpum*),
- Wild onion, and
- Beardtongue.

On gravelly to rocky, shallow hillsides, both bluebunch wheatgrass and black sagebrush are found, in addition to higher amounts of mat forbs. On sites close to the sandhills and sandy soils adjacent to Baggs, Wyoming, bitterbrush co-dominates. Larkspur (*Delphinium nuttallianum*) and death camas (*Zygadenus venenosus*) are poisonous plants also occurring in this cover type.

The value of ATW as an important winter browse species cannot be over emphasized. Monitoring transect data from the crucial winter range along Muddy Creek shows severe browse use of ATW during harsh winters, with light to moderate use in the transition range to the east that covers much of the project area. However, during mild winters, transition range browsing increases as animals can remain more dispersed, while crucial winter range browsing

CHAPTER 3. AFFECTED ENVIRONMENT

decreases, allowing potential recovery of crucial winter habitat during more favorable weather periods. However, comparison of trend studies between 1988 and 2006 document a 41-percent decline in shrub cover and a 31-percent decline in mature plants. Although numbers of young plants have increased, so have the number of decadent plants. Causes for these declines likely include increasing antelope populations, drought, and change from long duration to rotational grazing use by cattle (Warren 2006).

There are very few wildfires and no previously conducted prescribed burns in ATW habitat due to the sparseness of fuels to carry a fire. Recovery time for ATW to reoccupy a site after a fire occurrence is estimated at 75 to 150 years. Reclamation rates for ATW are also expected to take many years, but are currently unknown.

3.5.1.3 Alkali Sagebrush Cover Type

Alkali sagebrush (*Artemisia arbuscula* spp. *longiloba*) is a form of low sagebrush that grows on soils with high clay content. A large portion of these soils occur in the southern portion of the project area from Cherokee Creek south across Deep Creek to Cottonwood Creek, which comprises about 17,100 acres or 6 percent of the total area. Alkali sagebrush grows between 4 and 15 inches tall. Other common species found in this cover type of community are:

- Western wheatgrass,
- Little and mutton bluegrass,
- Bottlebrush squirreltail,
- Indian ricegrass,
- Hood's phlox,
- False dandelion,
- Hollyleaf clover,
- Penstemon,
- Wild onion, and
- Biscuitroot (*Lomatium* spp.).

Alkali sagebrush is considered palatable as forage, but use appears to be mostly light to moderate—well below use rates for Wyoming big sagebrush. Local knowledge about this species is very limited, however, general information developed from other areas support the following statements. Alkali sagebrush is usually killed by fire and does not resprout. Establishment from seed has been rated as medium, and establishment from transplants as very good. Seed production and handling are rated as medium because seeds are small. Natural spread by seed and vegetatively is good.

3.5.1.4 Basin Big Sagebrush Cover Type

Basin big sagebrush (*Artemisia tridentata* spp. *tridentata*), hereafter referred to as ATT, occurs on deeper, well-drained soils on about 9,200 acres or 3 percent of the project area. ATT is the dominant vegetation on floodplains bordering riparian habitat, and on ephemeral draws, valley sides, and leeward slopes where there is additional moisture and well-developed soils. It is found in association with black greasewood (*Sarcobatus vermiculatus*) and as small pockets within both ATW and ATVII cover types. Basin big sagebrush is the largest sagebrush in this area, with plants on drier sites ranging from 3 to 6 feet tall, and plants in floodplains reaching up to 10 feet. ATT may have taproots up to 20 feet deep, in addition to fibrous roots near the surface to benefit from local precipitation. Palatability of ATT is generally considered lower than

CHAPTER 3. AFFECTED ENVIRONMENT

ATW (Winward 1993). In fact, observations during winter of 1983–84 along Muddy Creek showed severe use of ATW compared to minimal use of ATT, even though animals were starving and some herd units had 50 percent die-off.

Common understory species in the ATT type include:

- Thickspike wheatgrass,
- Basin wildrye (*Leymus cinereus*),
- Little bluegrass,
- Kentucky bluegrass (*Poa pratensis*),
- Bluebells (*Mertensia spp.*),
- Lupine,
- Locoweed,
- Violet (*Viola spp.*),
- Louisiana sagewort (*Artemisia ludovicianna*),
- Aster (*Aster spp.*),
- False dandelion (*Agoseris spp.*),
- Butter cup (*Ranunculus spp.*),
- Wild onion,
- Groundsel (*Senecio spp.*),
- Povertyweed (*Iva axillaris*),
- Wild rose (*Rosa woodsii*),
- Snowberry,
- Rabbitbrushes, and
- Golden currant (*Ribes aureum*).

On some sites, bitterbrush, serviceberry, and true mountain mahogany grows. Since these sites are often close to water, historic and current grazing is often very common, and in some cases, excessive. Species like Kentucky bluegrass may proliferate while more sensitive species like basin wildrye may decrease in abundance. In addition, species that thrive from disturbance, such as cheatgrass (*Bromus tectorum*), become a component of this type.

Wildfires and prescribed burns both occur in this cover type. Where other species are uncommon or without post-burn grazing management, sagebrush cover may return to pre-treatment levels in 15 to 20 years. However, monitoring of prescribed burns with rest or deferment after treatment indicate ATT recovery may take up to 50 years to reach pre-treatment levels. Under this management, grasses and forbs are allowed to dominate the site initially, reducing the ability of sagebrush seedlings to establish themselves and out-compete other vegetation. The higher amount of moisture on these sites increases their productivity, and response to reclamation should be good (most previous reclamation efforts in this type have not been successful due to insufficient reclamation techniques compounded with recent drought conditions).

3.5.1.5 Juniper Woodland Cover Type

Utah juniper (*Juniperus osteosperma*) is the dominant tree in the juniper woodland cover type, which occurs on approximately 9,900 acres or 4 percent of the ARPA. They grow from 8 to 15 feet in height and width. Persistent stands are found on shallow, rocky soils with fractured rock substrate, where the juniper can root down to and take advantage of water that collects in

CHAPTER 3. AFFECTED ENVIRONMENT

these locations. Juniper will also encroach into adjacent big sagebrush stands. This cover type usually has a sparse to moderate cover of juniper trees over big sagebrush and true mountain mahogany. Other common understory species include:

- Bluebunch wheatgrass,
- Indian ricegrass,
- Little bluegrass,
- Canby bluegrass (*Poa canbyi*),
- Groundsel,
- Beardtongue,
- Phlox,
- Goldenweed,
- Miners candle (*Cryptantha spp.*),
- Twin bladderpod (*Physaria spp.*), and
- Occasionally some bitterbrush and black sagebrush.

Juniper stands grow along the western edge of the project area, adjacent to and within crucial winter range for mule deer. They provide important thermal cover and forage for mule deer and occasionally elk, as well as habitat for a variety of birds and small mammals. The stands of juniper closer to Baggs, Wyoming, are *yarding* areas where very high densities of mule deer reside during critical winter periods. Health of these stands is often very poor with severe browsing on an annual basis. This community type did not meet Rangeland Health Standard #3 (Upland Plant Health) or #4 (Wildlife Habitat) in the 2002 Upper Colorado River Basin Standards and Guidelines Assessment (USDI-BLM 2002e). When stands of Utah juniper become too dense, the understory of native grasses, forbs, and shrubs die out and are replaced with cheatgrass and annual forbs. Fire can be a useful tool in reducing juniper overstory and maintaining understory cover and composition. Where the understory is too sparse to carry a fire, some form of mechanical treatment may be needed to restore species diversity.

3.5.1.6 Aspen Woodland Cover Type

Aspen (*Populus tremuloides*) is the dominant tree in the aspen woodland cover type, which grows on approximately 434 acres of the ARPA. They grow from 5 to 30 feet tall at higher elevations (usually above 7000 feet amsl) on north and east slopes where wind-blown snow accumulates. This provides the moisture and deeper soils necessary to support aspen. Common understory shrubs include snowberry, serviceberry, creeping juniper (*Juniperus communis*), and Scouler's willow (*Salix scoulerianna*). A variety of grasses and forbs often dominate the understory, with elk sedge and Columbia needlegrass (*Achnatherum nelsonii*) the most common. Other species include:

- Mountain brome,
- blue wildrye (*Elymus glaucus*),
- Kentucky bluegrass,
- Columbine (*Aquilegia spp.*),
- Waterleaf (*Hydrophyllum spp.*),
- Bluebells,
- Wild licorice (*Glycyrrhiza*),
- Bedstraw,
- Heartleaf arnica (*Arnica spp.*),

CHAPTER 3. AFFECTED ENVIRONMENT

- Fairybells (*Disporum spp.*),
- Solomons seal (*Polygonatum spp.*),
- Yampa (*Perideridia spp.*), and
- Sweet-cicely (*Osmorhiza spp.*).

Many aspen stands are diseased, dying out, and being overtaken by serviceberry, big sagebrush, and creeping juniper. This community type did not meet Rangeland Health Standard #3 (Upland Plant Health) in the 2002 Upper Colorado River Basin Standards and Guidelines Assessment (USI-BLM 2002e). The use of fire can often remove competing species and stimulate regeneration. These habitats provide diverse vertical structure for many bird species and forage/hiding cover for mule deer and elk, and support numerous other wildlife species.

3.5.1.7 Greasewood and Greasewood/Basin Big Sagebrush Cover Types

Black greasewood is the dominant species on saline soils along floodplains and ephemeral drainages, particularly along portions of Muddy Creek and Wild Cow Creek. It occupies approximately 3,400 acres (1 percent) of the ARPA. This species also encroaches into the big sagebrush and saltbush steppe cover types, taking advantage of where it can find additional moisture. Although considered poisonous, it is often observed being eaten by livestock and big game species. Understory species composition is not as diverse as the big sagebrush cover types, with common species including:

- Basin wildrye,
- Western wheatgrass,
- Little bluegrass,
- Bottlebrush squirreltail,
- Inland saltgrass (*Distichlis stricta*),
- Biscuitroot,
- Wild onion,
- Pepperweed (*Lepidium spp.*), and
- Gardner's saltbush (*Atriplex gardneri*).

On some sites there are patches or intermixing with stands of basin big sagebrush.

3.5.1.8 True Mountain Mahogany and Serviceberry Cover Types

True mountain mahogany occurs as the dominant cover on shallow, rocky hillsides, and may be adjacent to juniper woodland. It occurs on approximately 800 acres (less than 1 percent) within the ARPA. Shrubs grow from 2 to 7 feet tall depending on the soils and precipitation. Serviceberry occurs as the dominant cover on shallower soils. It occurs on approximately 100 acres. These species, along with bitterbrush, are highly sought out by mule deer in the fall and winter months. Health of these stands in mule deer winter concentration areas is often very poor with severe browsing on an annual basis. These community types did not meet Rangeland Health Standard #3 (Upland Plant Health) or #4 (Wildlife Habitat) in the Upper Colorado River Basin Standards and Guidelines Assessment (USDI-BLM 2002e). Common understory species are similar to those described for juniper woodlands (section 3.5.1.5).

CHAPTER 3. AFFECTED ENVIRONMENT

3.5.1.9 Saltbush Steppe Cover Type

Gardner's saltbush is the characteristic species of this cover type, found on upland saline soils in small openings or linear *stringer* stands within Wyoming big sagebrush or black greasewood cover types. Since most stands of this cover type are too small to delineate from other cover types, the acreage is underestimated, but would still be less than 1 percent of the ARPA if accurately tallied. These stands are sparsely vegetated, with bare soil often exceeding 60 percent of the total surface cover. Plants usually grow 4 to 10 inches in height. Other common species in this cover type are:

- Little bluegrass,
- Indian ricegrass,
- Bottlebrush squirreltail,
- Western wheatgrass,
- Phlox,
- Biscuitroot,
- Wild onion,
- Pepperweed,
- Winterfat, and
- Birdsfoot sagebrush (*Artemisia pedatifida*).

Pronghorn antelope and livestock use this species on a year-round basis.

3.5.1.10 Silver Sagebrush/Bitterbrush/Rabbitbrush Cover Type

Stabilized sand dunes characterize this plant community, which is found within and bordering the Sandhills Area of Critical Environmental Concern (ACEC) along the eastern border of the ARPA. The deep sand soil supports denser stands of silver sagebrush and bitterbrush, with rabbitbrush in the understory, and pockets of serviceberry, chokecherry, snowberry, and aspen occur in wetter locations. Typical grass species include Needle-and-thread, Indian ricegrass, prairie sandreed (*Calamovilfa longifolia*), and western wheatgrass. The shrub species are very important as forage and cover for big game species, with much of this area identified as crucial winter range for mule deer. This cover type occurs on 1,500 acres; less than 1 percent of the project area.

3.5.1.11 Riparian Cover Types

Riparian habitat comprises approximately 250 acres within the ARPA along perennial and intermittent drainages and around seeps and springs. Although small in extent, these areas are the most diverse and productive of all vegetated sites, and are therefore extremely important for wildlife habitat and livestock forage. In common use, the term riparian can be synonymous with wetlands and include areas exhibiting vegetation or physical characteristics that reflect the influence of surface or subsurface water. Portions of these community types did not meet Rangeland Health Standard #2 (Wetland/Riparian Habitat) in the Upper Colorado River Basin Standards and Guidelines Assessment (USI-BLM 2002e). Three different community types can be distinguished in the project area: cottonwood/willow, willow/waterbirch, grassland/wetland, and man-made reservoirs/pits.

Cottonwood/willow habitat comprises about 20 percent of the total riparian cover type (about 50 acres), and is found in the southern portion of the ARPA along Cottonwood Creek, Youngs

CHAPTER 3. AFFECTED ENVIRONMENT

Draw, and Deep Creek. These drainages are intermittent, except below artesian wells along sections of Cottonwood Creek. Narrowleaf cottonwood (*Populus angustifolia*) may grow up to 50 feet tall and requires scouring runoff events to prepare seedbeds for germination. Coyote willow (*Salix exigua*) and wild rose are the principle understory shrubs, with basin wildrye, Kentucky bluegrass, inland saltgrass, and thickspike wheatgrass the primary understory grasses.

Willow/waterbirch habitat comprises about 10 percent of the total riparian cover type (about 25 acres), and is found along Muddy Creek north of Doty Mountain and along Separation Creek in the northern portion of the ARPA. Although intermittent in the late summer and fall months, these stream reaches are sufficiently wet to support water-loving species. Shrub species include:

- Coyote and yellow (*Salix lutea*) willow,
- Waterbirch (*Betula occidentalis*),
- Shrubby cinquefoil (*Potentilla fruticosa*),
- Wild rose, and
- Golden currant.

Willows are usually 3 to 6 feet tall, with waterbirch reaching 15 feet in height. Common understory grass or grass-like species are:

- Kentucky bluegrass,
- Inland saltgrass,
- Redtop (*Agrostis alba*),
- Streambank wheatgrass (*Elymus trachycaulum*),
- Meadow barley (*Hordeum brachyantherum*),
- Baltic rush (*Juncus balticus*),
- Spike-sedge (*Eleocharis* spp.),
- Tufted hairgrass (*Deschampsia cespitosa*),
- Northern reedgrass (*Calamagrostis inexpansa*),
- Common reed (*Phragmites communis*),
- Nebraska sedge (*Carex nebrascensis*),
- Beaked sedge (*Carex rostrata*),
- American bulrush (*Scirpus americanus*), and
- Pondweed (*Potamogeton* spp.).

Forbs include:

- Asters,
- Locoweed,
- Goldenrod (*Solidago canadensis*),
- Licoriceroot (*Glycyrrhiza lepidota*),
- Lettuce (*Lactuca serriola*),
- Mint (*Mentha arvensis*),
- Willowweed (*Epilobium glandulosum*),
- Plantain (*Plantago eriopoda*), and
- Strawberry potentilla (*Potentilla anserina*).

CHAPTER 3. AFFECTED ENVIRONMENT

Grassland riparian/wetland habitat is the most common type of riparian plant community in the ARPA, totaling about 70 percent of all riparian cover types. These areas may contain wetlands if sufficient hydrology is present to support the development of hydrophytic vegetation and hydric soils. These sites are diverse and composition depends on the quantity and quality of water supporting it. It is common for one or two species to dominate the composition of a particular site. Species are, for the most part, similar to those listed above. Although shrubs are not always present, the principle species—coyote willow—is not usually abundant. Wetter sites, like along Fillmore Creek, Cow Creek, and Cherokee Creek, contain more sedges. Drier sites, like those found along Dry Cow drainage, Wild Cow Creek and Deep Creek, are dominated by grasses and Baltic rush.

The fourth type of riparian/wetland communities is located in small, man-made reservoirs and pits which do not dry up on most years. These ponds are scattered throughout the ARPA, but typically occur in areas with higher clay content and water-holding capability. Salinity varies depending upon the source of water for each water body. Vegetation is dominated by grass and grass-like species including: spike-sedge, Baltic rush, Nebraska sedge, streambank wheatgrass, Kentucky bluegrass, redtop, alkaligrass, and foxtail barley.

3.5.2 Noxious and Invasive Weeds

On February 3, 1999, Executive Order (EO) 13112 was signed by President Clinton. The primary purpose of this EO was to prevent the introduction of invasive species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species cause. In Wyoming, some 428 species have been documented as invasive (Wyoming Weed and Pest Council 2006). Of these 428 plants, 24 are designated as noxious by the State of Wyoming (Rice 2002) and are shown in table 3-30. In addition to these 24 state-designated species, Carbon County has designated halogeton (*Halogeton glomeratus*), plains prickly pear (*Opuntia polyacantha*), Geyer larkspur (*Delphinium geyeri*), and lupine (*Lupinus spp.*) as noxious (Wyoming Weed and Pest Council 2006). Noxious weeds are very aggressive, and invading infestations tend to exclude other native plant species and reduce the overall forage production of desirable shrubs, herbaceous grasses, and forbs. The project area is vulnerable to infestations of noxious weeds, especially on newly disturbed surfaces. However, a majority of the project area contains sufficient assemblages of native plants to deter invasive, but not noxious, weed establishment in undisturbed habitat.

Noxious weeds known to occur or that have been treated within the ARPA are Russian knapweed, Canada thistle, whitetop, and musk thistle. Russian knapweed has been treated along the BLM road on the east side of Wild Horse Butte and occurs by the gate just south of the Morgan Ranch homestead. Canada thistle commonly occurs along Muddy Creek and grows on the eroding banks between the riparian habitat and the upland basin big sagebrush plant community. It has not been a problem and is extensive enough to require a large-scale effort to eradicate it. Treatment of Canada thistle is not emphasized due to greater concern for other noxious species that are more invasive or poisonous. Whitetop has only been documented along the county road by Cow Creek; its current status needs to be field-checked. Musk thistle has also been documented on the east side of Wild Horse Butte.

Halogeton, an invasive poisonous weed, has been present in the project area for many years, occurring in disturbed areas such as roadsides, old bedgrounds, and corrals. These populations did not appear to be expanding with minimal expansion of disturbed surface areas.

CHAPTER 3. AFFECTED ENVIRONMENT

However, with expansion of disturbance as a result of the interim drilling for CBNG, halogeton has expanded along roads and pipelines with inadequate control treatments and reclamation.

Table 3-30. Designated Noxious Weeds in Wyoming.¹

Scientific Name	Common Name
<i>Agropyron repens</i>	Quackgrass
<i>Ambrosia tomentosa</i>	Skeletonleaf bursage
<i>Arctium minus</i>	Common burdock
<i>Cardaria draba, C. pubescens</i>	Hoary cress, whitetop
<i>Carduus acanthoides</i>	Plumeless thistle
<i>Carduus nutans</i>	Musk thistle
<i>Centaurea diffusa</i>	Diffuse knapweed
<i>Centaurea maculosa</i>	Spotted knapweed
<i>Centaurea repens</i>	Russian knapweed
<i>Chrysanthemum leucanthemum</i>	Ox-eye daisy
<i>Cirsium arvense</i>	Canada thistle
<i>Convolvulus arvensis</i>	Field bindweed
<i>Cynoglossum officinale</i>	Houndstongue
<i>Euphorbia esula</i>	Leafy spurge
<i>Isatis tinctoria</i>	Dyers woad
<i>Lepidium latifolium</i>	Perennial pepperweed
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Linaria vulgaris</i>	Yellow toadflax
<i>Lythrum salicaria</i>	Purple loosestrife
<i>Onopordum acanthium</i>	Scotch thistle
<i>Sonchus arvensis</i>	Perennial sowthistle
<i>Tamarisk spp.</i>	Salt cedar
<i>Hypericum perforatum</i>	Common St. Johnswort
<i>Tanacetum vulgare</i>	Common tansy

Note:

¹ Designated Noxious Weeds, Wyoming Stat. § 11-5-102 (a)(xi) and Prohibited Noxious Weeds, Wyoming Statute § 11-12-104.

Noxious and invasive species known to occur outside, but adjacent to the project area, include houndstongue, salt cedar, and spotted knapweed. Houndstongue is common in the Loco Creek and Savery drainages east of the south end of the ARPA. Some locations have been treated, but there are too many plants to effectively treat all locations at this time. Salt cedar is found along the middle and lower sections of Muddy Creek. Treatment was generally successful in the fall of 2005 to eliminate the largest populations above the George Dew homestead, but further treatments are still required to eradicate all salt cedar plants. Spotted knapweed has shown up from time to time, primarily along highways. A recent discovery documented this species along Highway 789 between milepost markers 10 and 21, and treatments will be planned to control it. Black henbane primarily occurs along roads and pipelines, and has been documented adjacent to the project area along gas field, BLM, and county roads.

Some of these species require disturbance to become established and some do not. What appears to be more critical is the transportation of seeds along highways and roads via vehicles and construction equipment that can only be controlled by more education and enforcement of washing vehicles to reduce the likelihood of seed movement.

CHAPTER 3. AFFECTED ENVIRONMENT

3.6 Range Resources

The ARPA overlaps 31 BLM grazing allotments (map M-20), totaling 574,688 acres that are permitted for 39,695 cattle and 7,421 sheep animal unit months (AUMs) (table 3-31). The season of use for each allotment varies, but most are for a combination of spring, summer, or fall with pastures for control of season and duration. In many cases, the boundaries of the grazing allotments extend beyond the boundaries of the ARPA. This document will focus on those allotments that are mostly within the ARPA (listed in table 3-31 in bold) unless specifically mentioned.

Table 3-31. Grazing Allotments and Animal Unit Months (AUMs) Currently Permitted in the Atlantic Rim Project Area.¹

Allotment Name	Total Acres	Allotment % in ARPA	BLM Acres and Permitted AUMs			
			Acres	Cattle AUMs	Sheep AUMs	Total AUMs
Adams Ranch	199	67	39	6		6
Airheart Pasture	1861	74	520	96		96
Badwater	21,777	8	10,251	802	399	1,201
Baggs Sub-Unit	8,411	88	3,965	264		264
Brimmer Pastures	1,325	44	291	18		18
Bull Canyon	7,688	26	3,833	748		748
Cherokee	66,799	94	62,706	6,412	1,588	8,000
Cottonwood Creek	5,040	100	200	17	17	34
Dad	433	9	433	94		94
Daley Ranch	26,083	13	11,305	959		959
Deep Creek Pasture	6,172	100	1,571	635		635
Deep Gulch	35,452	60	26,954	3,597		3,597
Doty Mountain	84,008	67	59,504	6,976		6,976
East Muddy	6,154	91	5,484	301		301
Fillmore	39,923	61	17,449	3,374		3,374
Grizzly	38,091	8	27,533	5,280		5,280
Headquarters Ranch	612	97	142	25		25
JO Pastures	1,136	100	1,136	600		600
Morgan-Boyer	11,163	9	8,260	1,002	700	1,702
Morgan Ranch	4,930	100	2,780	263		263
North Baggs	741	6	179	18		18
Rasmussen Sub-unit	19,411	11	4,751	792		792
Sixteen Mile	81,509	31	37,513	2,442	1,186	3,628
Smiley Draw	3,540	100	1,345	226		226
South LaCleda	60,436	1	34,328	233	3,531	3,764
South Muddy	1,562	90	1,562	103		103
South Pasture	3,880	95	497	89		89

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-31. Grazing Allotments and Animal Unit Months (AUMs) Currently Permitted in the Atlantic Rim Project Area.¹

Allotment Name	Total Acres	Allotment % in ARPA	BLM Acres and Permitted AUMs			
			Acres	Cattle AUMs	Sheep AUMs	Total AUMs
Sulphur Springs	22,752	21	12,832	2,096		2,096
West Loco	920	67	120	30		30
West Wild Cow	3,835	100	3,502	437		437
Wild Cow	8,815	59	7,868	1,760		1,760
Totals	574,688		348,096	39,695	7,421	47,116

Note:

¹ Allotment names in bold are those primarily affected and are discussed in text.

There are 21 allotments within the ARPA that would be primarily affected by the proposed action or an alternative (30 percent allotment acres or higher within ARPA). These allotments contain 372,444 acres (64 percent public) and 30,462 permitted AUMs. Thirteen different livestock operations have permitted use in these allotments, with most having private (single operator) allotments. However, in Cherokee allotment, use is shared between seven permittees. The total AUMs in the ARPA are split into 27,671 cattle AUMs (91 percent) and 2,791 sheep AUMs (9 percent); a small amount of is used by ranch horses. The total permitted AUMs within these 21 allotments equal about 7.8 acres per AUM across the ARPA.

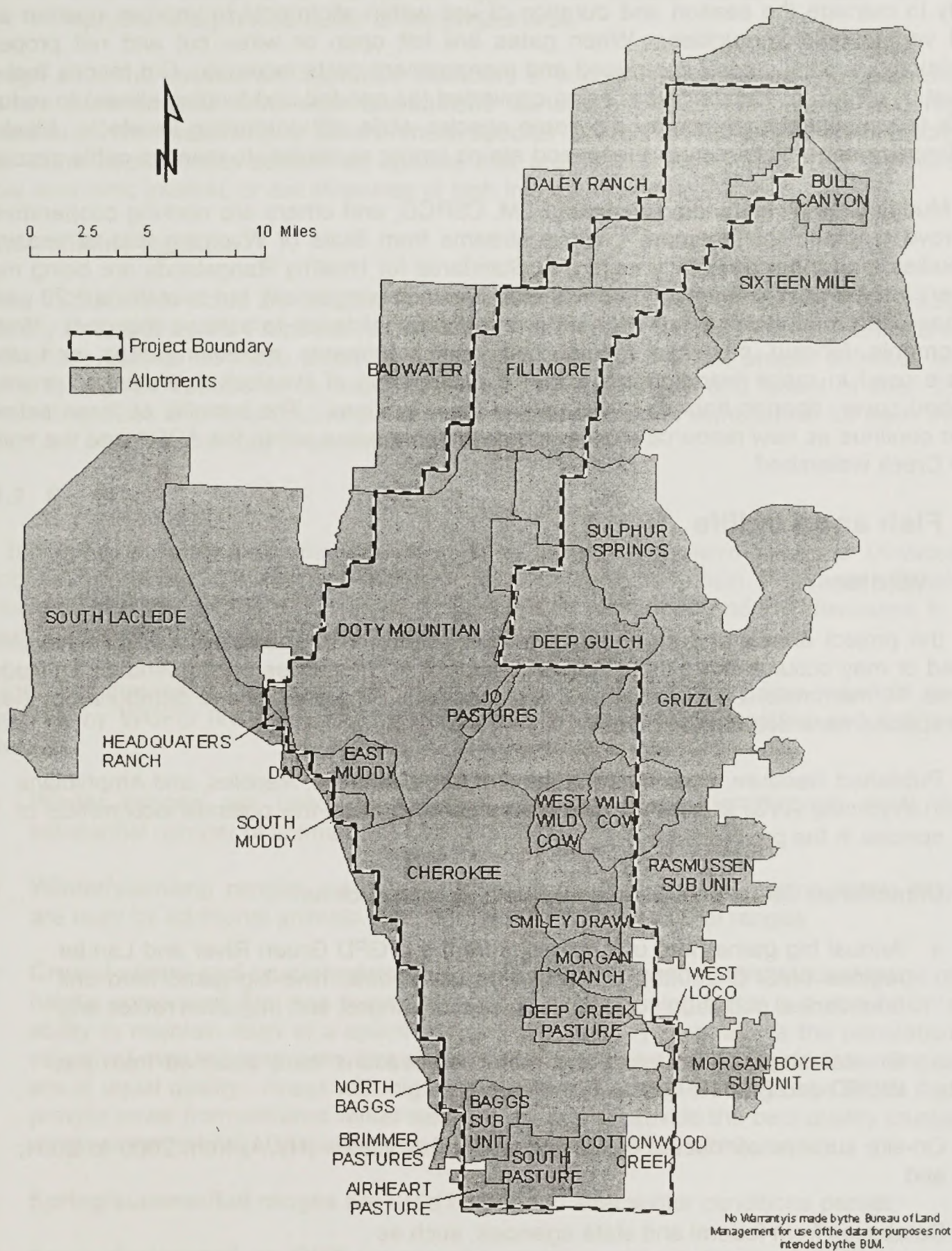
Cattle operations are primarily cow/calf pairs, but three allotments (Deep Gulch, Fillmore, and JO Pastures) are typically used by yearlings. Each allotment is usually used for one season, unless use is rotated between pastures. Most ranchers calve on private land before moving out to an allotment. Two permittees range calves on their allotments, but in pastures outside the area of the ARPA. Pastures with corrals essential for livestock gathering and shipping activities are used periodically, but use varies by operation. Yearlings, cows, and calves are trucked in to the corrals between April and June. Yearlings are rounded up and trucked out anytime between mid-August to September; cows and calves, from October through December.

Sheep use is primarily during May and June for lambing, with lesser amounts of use in late September and October. In addition, sheep trail to and from desert (winter) allotments to lamb, then trail to and from the National Forest where they spend the summer. Most active sheep are grazed within the Cherokee allotment by two operators. Within Cherokee, these two operators primarily lamb in the Cottonwood Creek, Deep Creek, and Wild Cow Creek drainages. However, the sheep are trailed across Doty Mountain, East Muddy, and Smiley Draw allotments. Corrals or pens for sheep may be permanent, but often are temporary and installed at the location needed to work the sheep. These are usually on the lambing grounds to shear the sheep in late April or early May or to brand, cut, and dock the lambs in late May or early June.

Most ranchers have lived and worked within the project area for three to four generations. Their knowledge is extensive about not only livestock management, but also local information, such as where the snow blows free or collects, when the country opens up, when the ice comes out of the storm channels, and where and when wildlife move within allotments. This information is useful in planning and reducing impacts, and ranchers should be encouraged to participate in coordinating long-term development, production, and reclamation activities.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-20. Grazing Allotments.



CHAPTER 3. AFFECTED ENVIRONMENT

Livestock rely on artesian water wells and seeps along drainages to water livestock. Fences have been constructed through the years to control livestock within allotments, and more recently to manage the season and duration of use within allotments to improve riparian and upland vegetation communities. When gates are left open or wires cut and not properly reconstructed, animal control is reduced and management costs increase. Old fences that do not meet current BLM standards are being converted (as needed and funding allows) to reduce impacts to movement/migration by big game species while still controlling livestock. Most of these fences were built to control sheep, and are no longer necessary to manage cattle grazing.

In the Muddy Creek watershed, ranchers, BLM, LSRCD, and others are working cooperatively to improve resource management, remove streams from State of Wyoming lists of impaired waterbodies, and more recently ensure that Standards for Healthy Rangelands are being met. Ranchers have always sought to improve their livestock management, but over the last 20 years there has been more emphasis with state and federal assistance to achieve this goal. Water developments, fencing, pasture rotations, vegetation treatments, monitoring sites, and other tools are used in range management with the cooperation of livestock operators to improve watershed cover, riparian habitat, and upland plant conditions. The benefits of these actions need to continue as new resource uses and development occur within the ARPA and the entire Muddy Creek watershed.

3.7 Fish and Wildlife

3.7.1 Wildlife

Within the project area and surrounding region, a total of 338 species of wildlife have been recorded or may occur either as residents or migrants. This species list (appendix D) includes 248 birds, 73 mammals, 11 reptiles, and 6 amphibians. The presence and distribution of these wildlife species were determined from:

- Published literature, such as the Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming (WGFD 1999), which was used to assess the potential occurrence of species in the project area;
- Unpublished data from federal and state agencies, such as:
 - Annual big game herd unit reports from the WGFD Green River and Lander regions (WGFD 2003b), which were used to determine big game herd unit boundaries, population objectives, seasonal ranges, and migration routes and
 - Greater sage-grouse lek and raptor nest locations were obtained from the WGFD and BLM RFO;
- On-site surveys conducted by Hayden-Wing Associates (HWA) from 2000 to 2004; and
- Databases from federal and state agencies, such as
 - The WGFD Wildlife Observation System (WOS), which contains records of observations for all types of wildlife (WGFD 2003a) and

CHAPTER 3. AFFECTED ENVIRONMENT

- The Wyoming Natural Diversity Database (WYNDD 2003), which was used to find the locations of vertebrate species of special concern within an approximately 6-mile buffer of the project area.

Although all of the species are important members of wild land ecosystems and communities, most are common and have wide distributions within the project area, state, and region. Consequently, the relationship of most of these species to the proposed project is not discussed in the same depth in this section as species that are threatened, endangered, sensitive, of special economic interest, or are otherwise of high interest or unique value.

3.7.1.1 Wildlife Habitats

Wildlife habitats that could be affected by the project include both the areas that would be physically disturbed by the Proposed Action and zones of influence surrounding them. Zones of influence are defined as those areas surrounding, or associated with, project activities where impacts to a given species or its habitat could occur. The shape and extent of such zones varies with species and circumstances. General vegetative species composition for each wildlife habitat type are characterized in section 3.5.2.

3.7.1.2 Big Game

The big game species that occur on the ARPA include pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*). Big game populations are managed by the WGFD within areas designated as herd units and are discussed in that context.

The following discussions about big game will discuss the types of big game seasonal ranges designated by WGFD (WGFD 1996). These seasonal ranges are identified and defined as follows:

- **Winter ranges** are used during winter months (November through April): a substantial number of animals uses winter ranges within the ARPA.
- **Winter/yearlong ranges** are occupied throughout the year, but during winter they are used by additional animals that migrate from other seasonal ranges.
- **Crucial winter and crucial winter/yearlong ranges** describe any seasonal range or habitat component that has been identified as a determining factor in a population's ability to maintain itself at a specified level (theoretically at or above the population objective) over the long term. Not all habitats within designated crucial winter ranges are of equal quality. Areas with higher quantity and quality of forage and areas that provide cover from extreme winter weather conditions provide the best quality crucial winter range habitat. Crucial ranges are typically used 8 out of 10 winters.
- **Spring/summer/fall ranges** are used before and after winter conditions persist.
- **Areas designated as OUT** (or non-use areas) contain habitats of limited or no importance to big game species.

CHAPTER 3. AFFECTED ENVIRONMENT

Using WGFD information that was averaged from 1997–2001, comparisons can be made about the richness and productivity of big game species across Wyoming. When numbers for antelope, mule deer, and elk are combined for similar-sized geographic units, the harvest data for the Sierra Madre/Snowy Range area (which includes the ARPA) within the area administered by the BLM RFO are similar to the Sublette region around Pinedale, which is considered the most productive big game region in the state. In addition, recreation days and the economic benefits associated with hunting were 50 percent higher for the Sierra Madre/Snowy Range area when compared to the Sublette region (USDI-BLM 2004c).

Pronghorn

The ARPA is located mostly within the 1,394-mile² Baggs Herd Unit for antelope, but is also located on very small portions of the Bitter Creek and Iron Springs Herd Units (map M-21). The project area covers 480 miles² or 34 percent of the Baggs Herd Unit.

Antelope did not meet Rangeland Health Standard #4 (Wildlife Habitat) in the Upper Colorado River Basin Standards and Guidelines Assessment (USDI-BLM 2002e), based on the following analysis. The population objective was raised in 1994 from 7,100 to 9,000 animals. Before raising this objective, antelope populations had tended to be at or above objective levels in most years. Whether the current herd objective is supportable is not yet known. Principal concerns within the Baggs antelope herd are tied to the 74 percent winter diet overlap with mule deer, and the high levels of browse use and health of the sagebrush habitat in crucial winter range (refer to section 3.5). The latter is caused by the concentration of animals in the Muddy Creek crucial winter range during severe winters and their inability to move through or under fences along Highway 789.

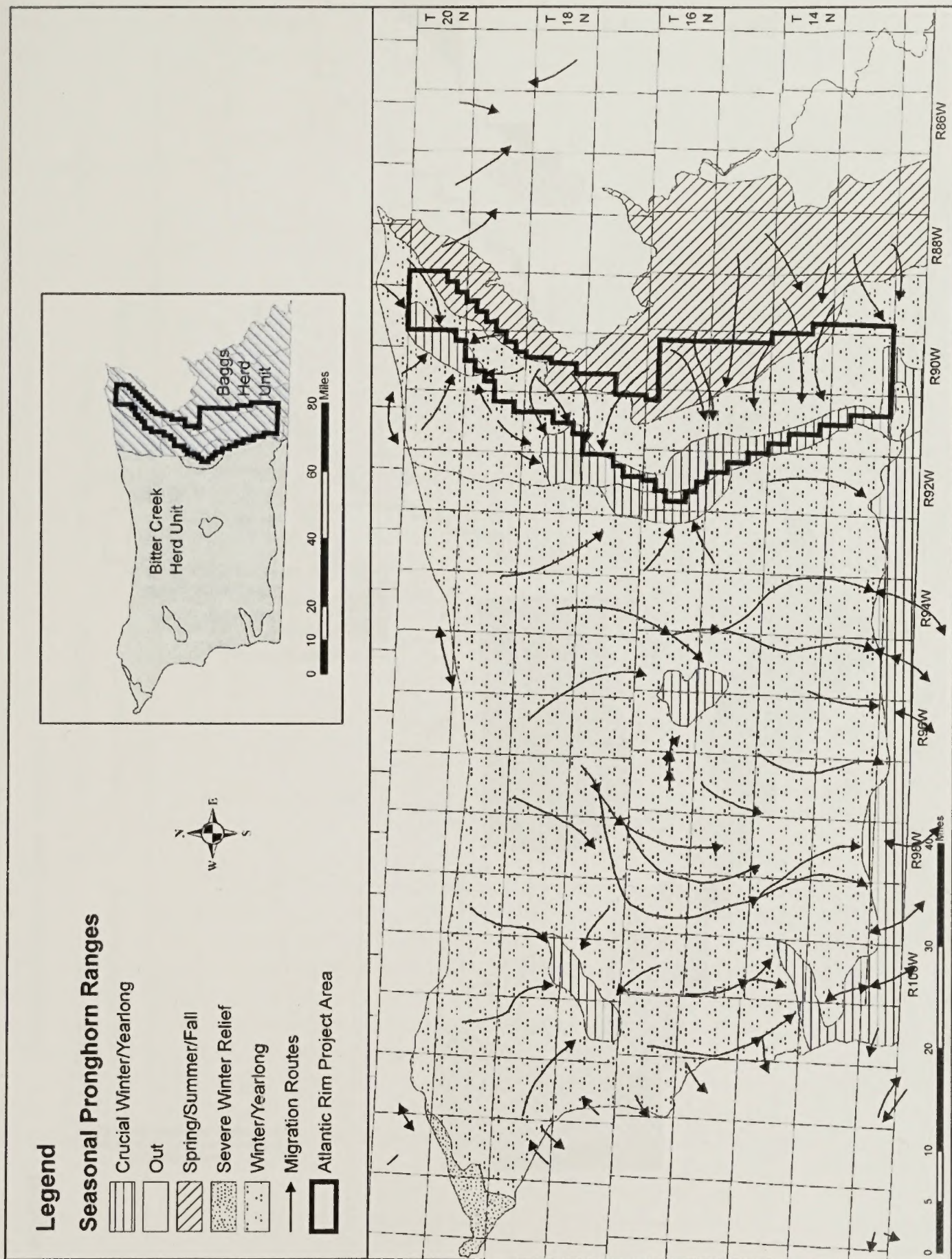
There are 42,900 acres of antelope crucial winter range, of which 24 percent is on private and state lands where there are no protections against disturbance of animals during critical time periods (map M-22). Current trends in the sagebrush community, a habitat that supports critical winter range, are stable. However, as populations are raised toward the higher population objective and when more severe winter weather returns to this portion of Wyoming, the trend in these communities should be closely watched. The transition range located on lower elevations adjacent to crucial winter range is important in receiving more use by antelope in milder winters and reducing the browsing pressure on the crucial winter range. The importance of big sagebrush to antelope can not be overstated, sagebrush comprises the majority of pronghorn diets (71 percent in summer and 96 percent in winter) (Alldredge and Deblinger 1988).

Mule Deer

The ARPA is located within the eastern portion of the 3,440-mile² Baggs Herd Unit (map M-23). The 2004 post-hunt population estimate for the Baggs Herd Unit was 21,000, but were previously as high as 27,000 in 1987 before a winter die-off in February 1993. This estimate is above the WGFD management objective of 18,700 (table 3-32). However, this area is one of few in Wyoming that supports deer harvest to manage deer numbers at objective levels. This is a reflection of the productivity of this deer herd and the quality of spring/summer/fall habitat that supports them.

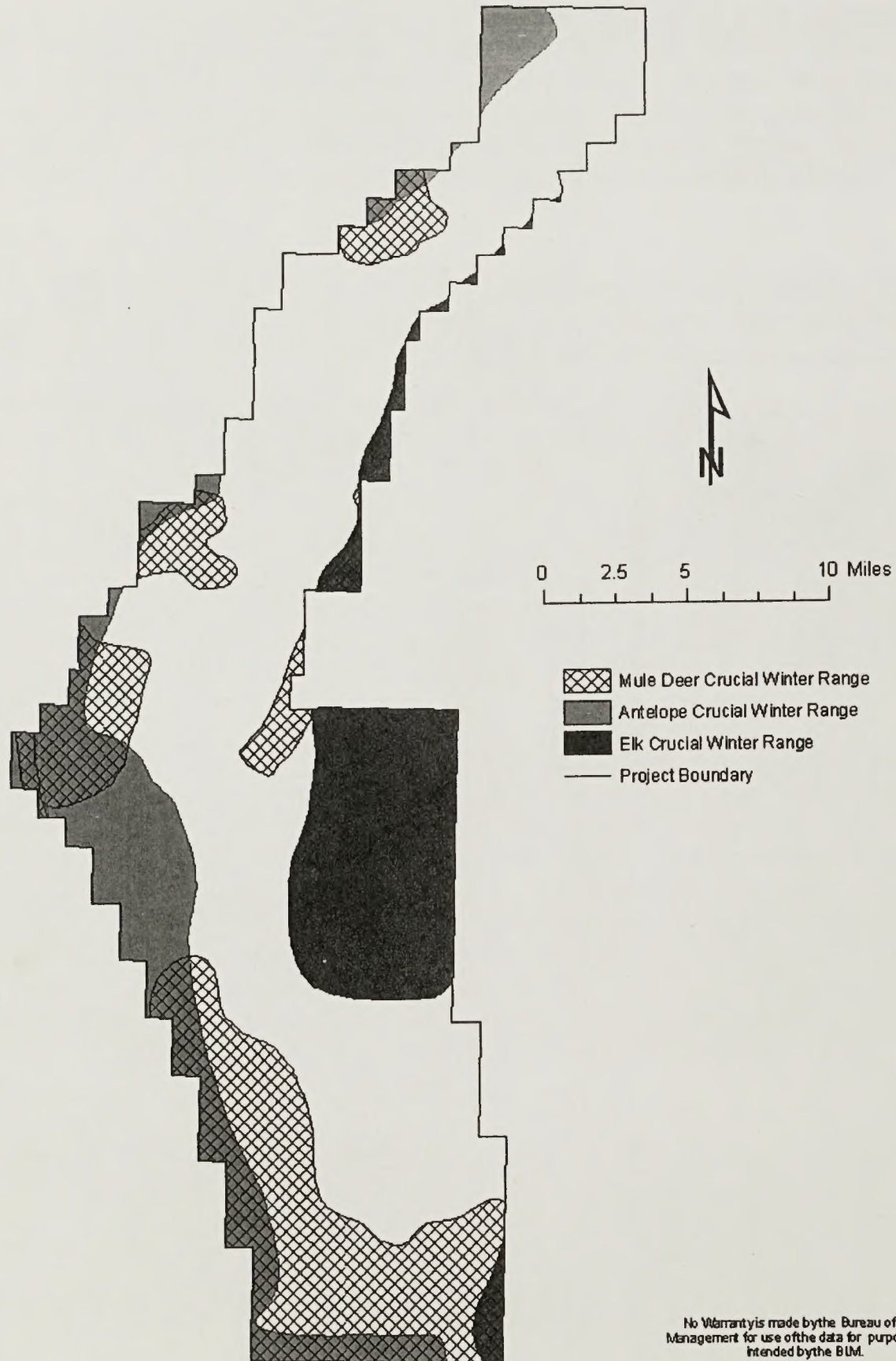
CHAPTER 3. AFFECTED ENVIRONMENT

Map M-21. Seasonal Pronghorn Ranges and Migrations Routes.



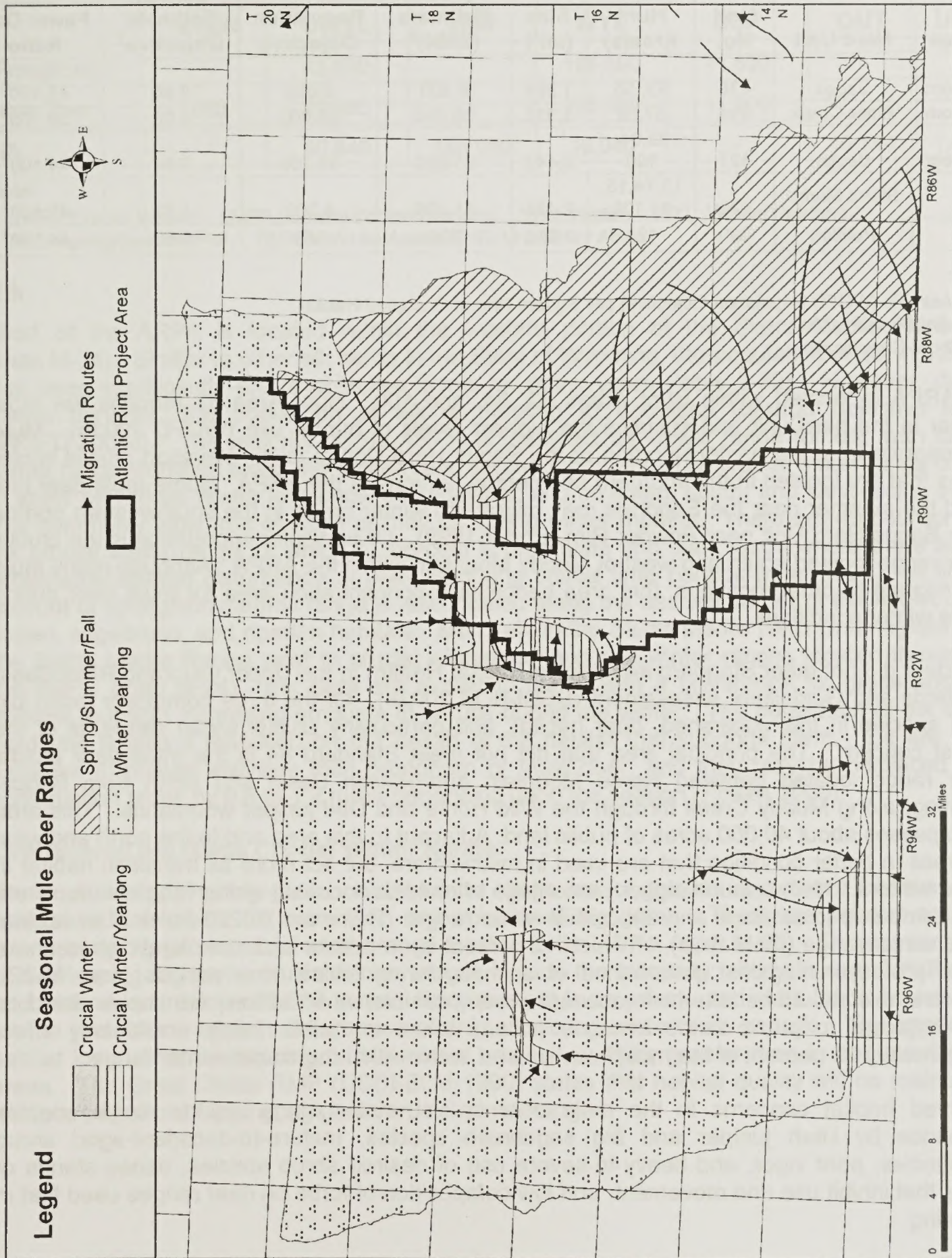
CHAPTER 3. AFFECTED ENVIRONMENT

Map M-22. Big Game Crucial Winter Ranges.



CHAPTER 3. AFFECTED ENVIRONMENT

Map M-23. Seasonal Mule Deer Ranges and Migrations Routes.



CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-32. Population Parameters for Big Game Herd Units within the ARPA.

Species	Herd Unit	Unit No.	Hunt Area(s)	Size (mi ²)	Population Estimate (2004) ³	Population Objective	Density Estimate Objective ¹	Fawn: Doe Ratio
Pronghorn	Baggs	438	53, 55	1,394	9,300	9,000	6.46	43:100 ²
Pronghorn	Bitter Creek	414	57,58	2,915	10,200	25,000	8.58	36:100 ²
Mule Deer	Baggs	427	82,84, 100	3,440	21,000	18,700	5.44	44:100 ³
Elk	Sierra Madre	425	13,14,15, 21,108	2,425	11,200	4,200	1.73	45:100 ³
Elk	Petition	430	124	2,915	300	300	0.10	44:100 ³

Notes:

¹ No. Animals (WGFD Population Objective) per Square Mile of Occupied Habitat

² Prehunt Classification

³ Posthunt Classification

The ARPA is located within Hunt Areas 82, 84, and 100. Hunt Area 82 remains the most popular in the herd unit and sustains the highest levels of hunter use (WGFD 2003b). Mule deer migrate from the eastern portion of the Baggs Herd Unit to lower elevation crucial winter ranges that are located in the southern and central portions of the ARPA. Some mule deer that spend the summer near the Sandhills may migrate to winter range in the southwestern portion of the Baggs Herd Unit near Powder Rim (Porter 1999). Of particular importance is the crucial winter range located south and west of Muddy Mountain within the ARPA. Although many mule deer migrate to other locations, this area becomes a concentration area for mule deer during severe winter conditions.

Mule deer did not meet Standard #4 (Wildlife Habitat Health) in the Upper Colorado River Basin Standards and Guidelines Assessment (USDI-BLM 2002e). Of the three commonly found big game species in this watershed, deer habitat, and particularly crucial winter range, is of the highest concern. The principal area that did not meet Standard #4 is the mule deer crucial winter range located between Horse Mountain and Poison Basin and north from Baggs, Wyoming, along Muddy Creek through the Wild Horse and Dad juniper woodlands. This area encompasses about 40,000 acres of public land. Adjacent to this area and to the north and west are areas in better condition that are used in mild winters, but act more as transition habitat in severe winters. Also, a much higher percentage of mule deer crucial winter range is on private lands compared to antelope and elk crucial winter range. There are 73,270 acres of mule deer crucial winter range (table 3-33), of which 42 percent is on private and state lands where there are no protections against disturbance of animals during critical time periods (map M-22). Therefore, this should be taken into account (when possible) when actions are implemented on lands adjacent to public lands because actions taken on public lands would only affect approximately 20 percent of the most heavily used areas within the crucial winter range.

Observed habitat concerns in the mule deer crucial winter range include single species dominance by Utah juniper and big sagebrush species, mature-to-decadent-aged shrub communities, poor vigor, and heavy-to-severe use of desired shrub species, dense stands of shrubs that inhibit use and movement, and low composition of forbs on deer ranges used first in the spring.

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-33. Big Game Seasonal Ranges within the Atlantic Rim Project Area.

	Seasonal Range ¹ Areas (acres)						
	CWIN	CWYL	WIN	WYL	SSF	OUT	UND
Pronghorn	-	42,900	-	155,690	71,590	-	-
Mule Deer	890	72,380	-	185,000	11,900	-	-
Elk	-	40,840	195,680	16,040	-	16,190	1,440

Note:

¹ CWIN: Crucial Winter, CWYL: Crucial Winter/Yearlong, WIN: Winter, WYL: Winter/Yearlong, SSF: Spring/Summer/Fall, OUT: Non-use Areas, UND: Undefined Areas.

Elk

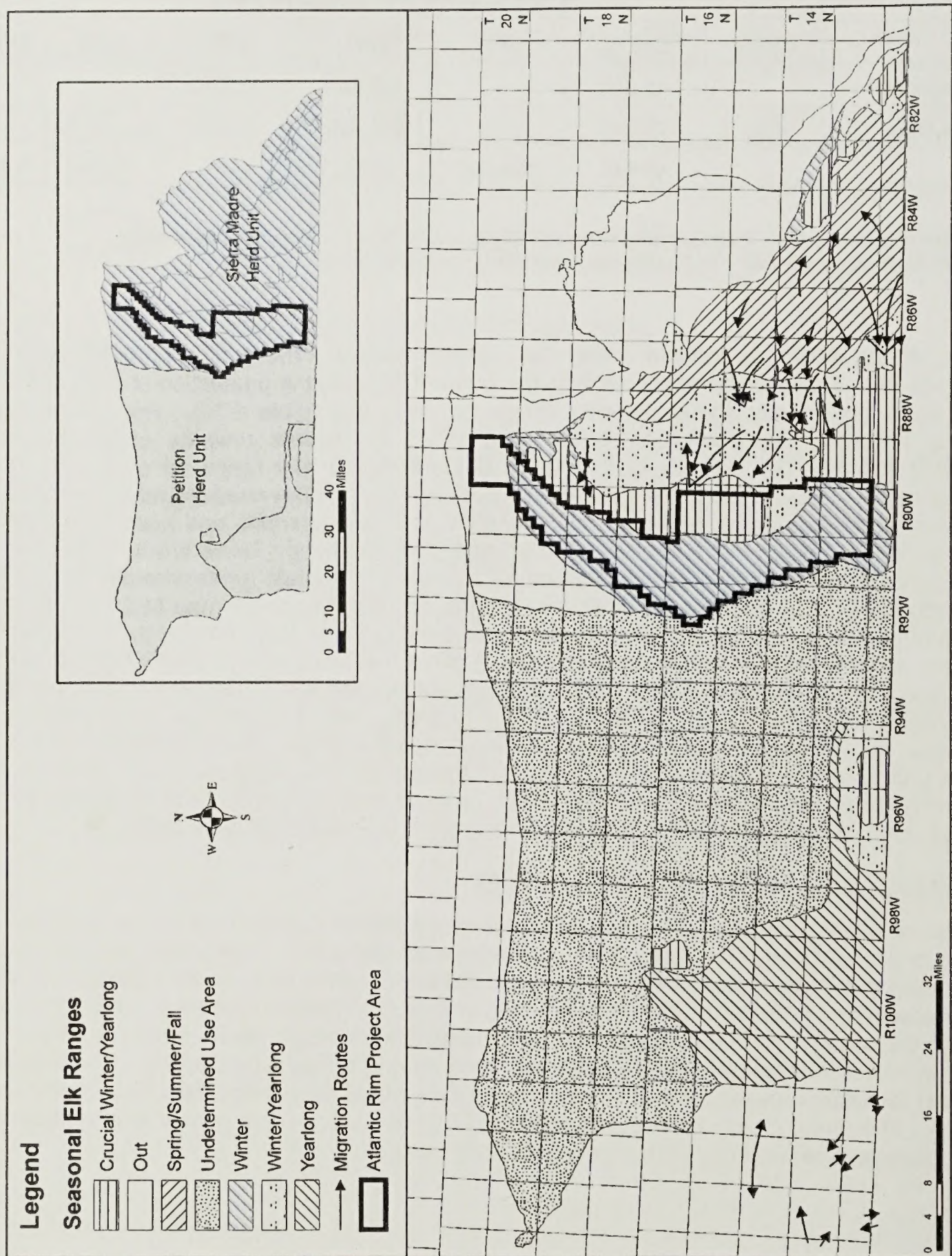
Most of the ARPA is located within the western portion of the Sierra Madre Herd Unit (map M-24). Similar to other elk herds in the State of Wyoming, the population of elk in this unit has been significantly above objective levels for many years (table 3-32). However, due to liberal harvests, the population of elk is trending to decrease towards objective levels (WGFD 2004c). The majority of the ARPA is identified as winter range for elk, with crucial winter range identified along the eastern and southern borders. The crucial winter range occurs at lower elevations where less snow accumulates, and on steep, south- and west-facing slopes that commonly blow free of snow or melt off during winter months. There are 40,840 acres of elk crucial winter range, of which 17 percent is on private and state lands where there are no protections against disturbance of animals during critical time periods (map M-22). A limited amount of spring/summer/fall range is also located along the eastern border of the ARPA in the aspen, sagebrush, and riparian habitats. Many elk in the Sierra Madre Herd Unit migrate from the Sierra Madre Range west to crucial winter/yearlong and winter ranges located throughout the ARPA (map M-24). Elk diets are similar to cattle, with a preference for grass and forb species, but with increasing amounts of shrubs during the winter. The population of elk in this herd unit is also a reflection on the health of the habitat that supports them. Elk are more sensitive to human activities than pronghorn or mule deer, and they may be displaced from construction areas by 0.6 to 1.2 miles depending upon the season (Powell 2003).

Overlapping Big Game Crucial Winter Range

Areas of overlapping big game crucial winter range are of greater importance because they provide crucial habitat for more than one species of big game. There are several areas of overlapping big game crucial winter range located in the ARPA (map M-25). The combinations of overlapping big game crucial winter ranges include the following: elk/mule deer 3,038 acres and mule deer/antelope 22,637 acres. Forty percent is on private and state lands where there are no protections against disturbance of animals during critical time periods. The impacts of habitat loss within overlapping crucial winter ranges would be greater than in non-overlapping areas. The Great Divide RMP (USDI-BLM 1990) states that habitat quality will be maintained within areas of overlapping big game crucial winter ranges.

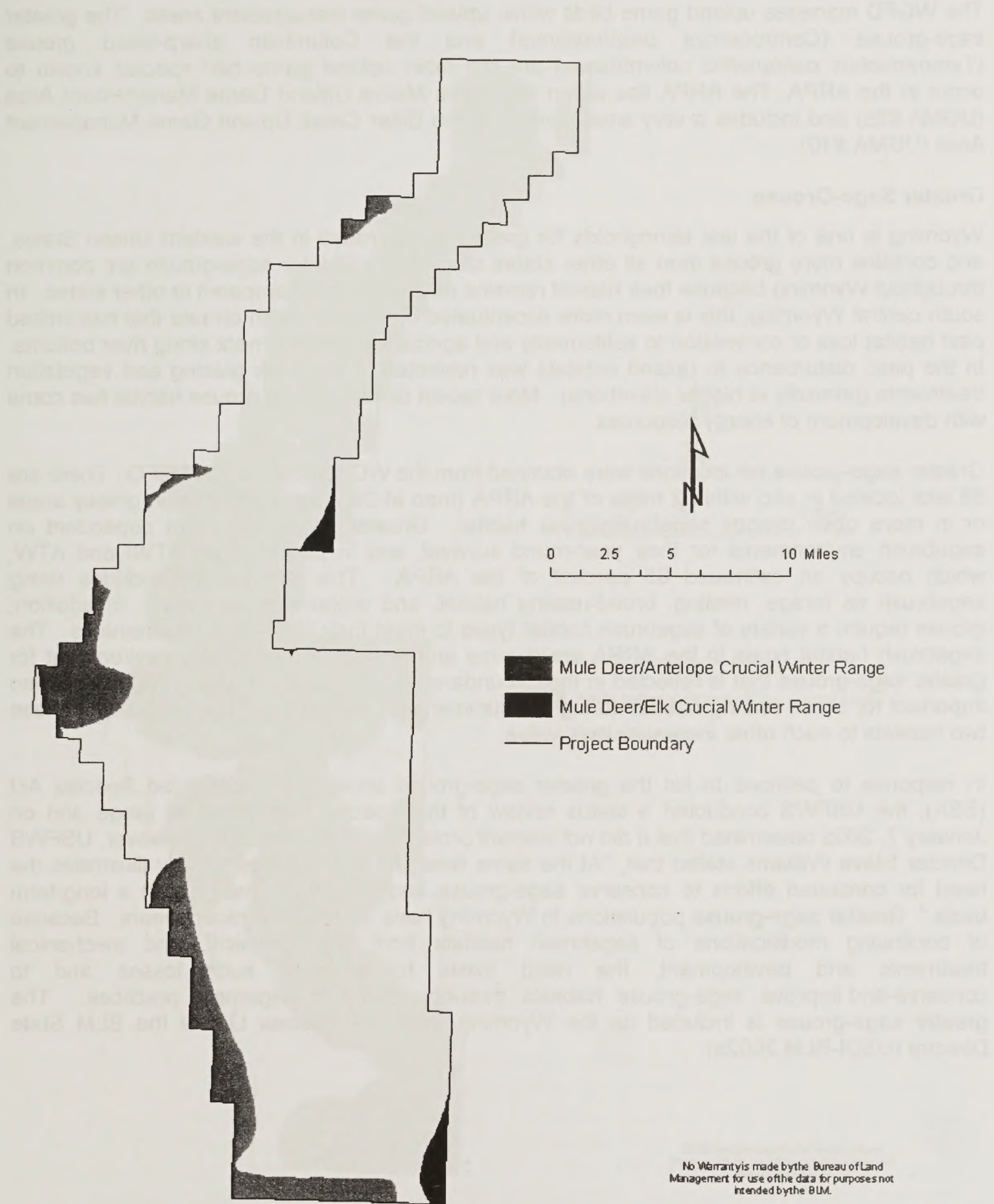
CHAPTER 3. AFFECTED ENVIRONMENT

Map M-24. Seasonal Elk Ranges and Migrations Routes.



CHAPTER 3. AFFECTED ENVIRONMENT

Map M-25. Overlapping Crucial Winter Ranges.



CHAPTER 3. AFFECTED ENVIRONMENT

3.7.1.3 Upland Game Birds

The WGFD manages upland game birds within upland game management areas. The greater sage-grouse (*Centrocercus urophasianus*) and the Columbian sharp-tailed grouse (*Tympanuchus pahianellus columbianus*) are the main upland game bird species known to occur in the ARPA. The ARPA lies within the Sierra Madre Upland Game Management Area (UGMA #25) and includes a very small portion of the Bitter Creek Upland Game Management Area (UGMA #10).

Greater Sage-Grouse

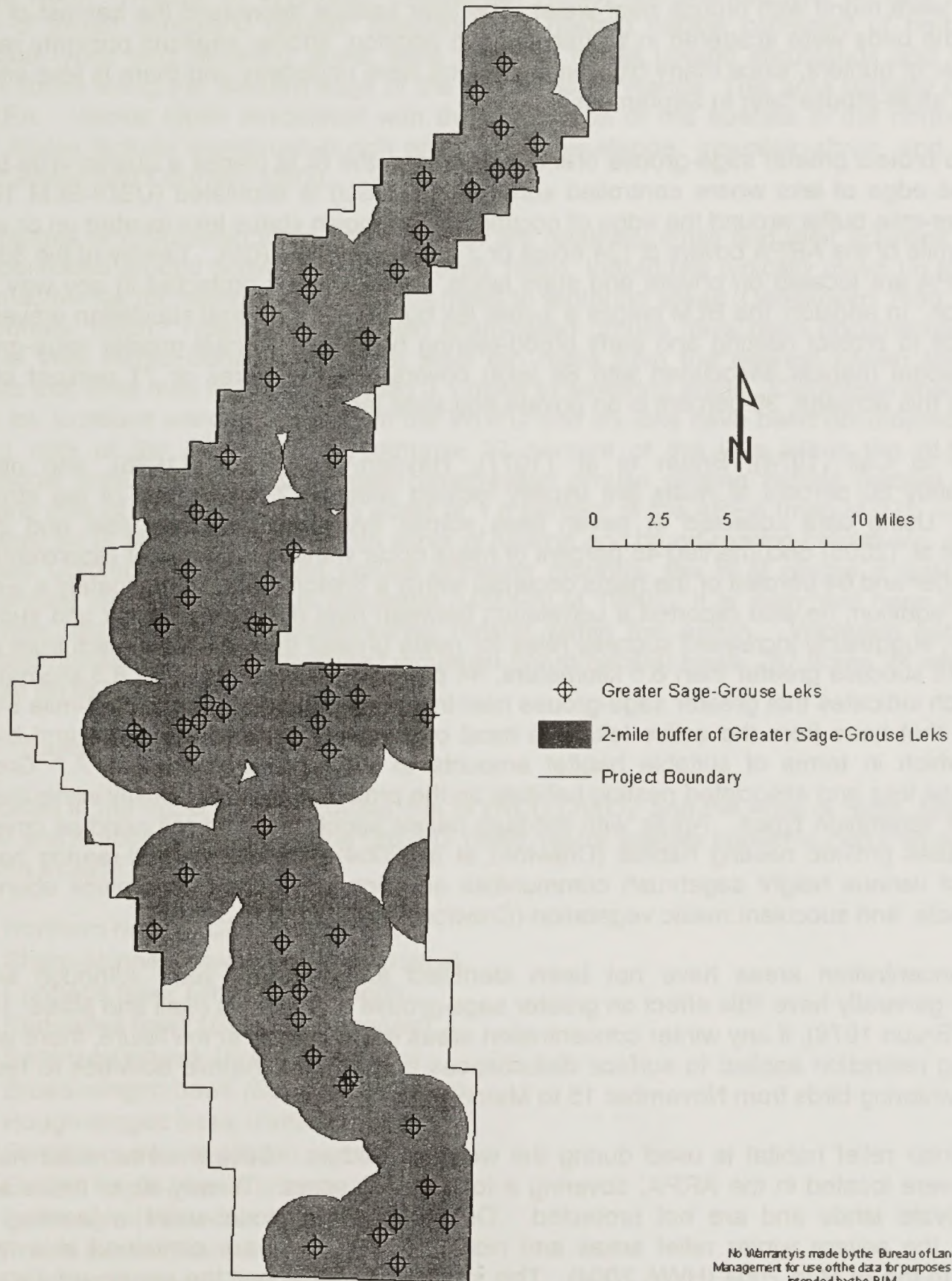
Wyoming is one of the last strongholds for greater sage-grouse in the western United States, and contains more grouse than all other states combined. Greater sage-grouse are common throughout Wyoming because their habitat remains relatively intact compared to other states. In south-central Wyoming, this is even more accentuated due to the harsh climate that has limited past habitat loss or conversion to settlements and agricultural development along river bottoms. In the past, disturbance to upland habitats was restricted to livestock grazing and vegetation treatments (primarily at higher elevations). More recent disturbance to grouse habitat has come with development of energy resources.

Greater sage-grouse lek locations were obtained from the WGFD and the BLM RFO. There are 88 leks located in and within 2 miles of the ARPA (map M-26). Leks are often in grassy areas or in more open canopy sagebrush/grass habitat. Greater sage-grouse are dependent on sagebrush environments for their year-round survival, and in particular on ATVII and ATW, which occupy an estimated 85 percent of the ARPA. This dependency includes using sagebrush as forage, nesting, brood-rearing habitat, and winter thermal cover. In addition, grouse require a variety of sagebrush habitat types to meet their life history requirements. The sagebrush habitat types in the ARPA are diverse and provide a high quality environment for greater sage-grouse that is reflected in their abundance in this area. Riparian habitats are also important for brood-rearing habitat during the summer and fall months. The proximity of these two habitats to each other increases their value.

In response to petitions to list the greater sage-grouse under the Endangered Species Act (ESA), the USFWS conducted a status review of this species throughout its range and on January 7, 2005 determined that it did not warrant protection under the ESA. However, USFWS Director Steve Williams stated that, "At the same time, the status review clearly illustrates the need for continued efforts to conserve sage-grouse and sagebrush habitats on a long-term basis." Greater sage-grouse populations in Wyoming have stabilized in recent years. Because of continuing modifications of sagebrush habitats from fire, chemical, and mechanical treatments and development, the need exists to minimize such losses and to conserve-and-improve sage-grouse habitats through careful management practices. The greater sage-grouse is included on the Wyoming Sensitive Species List of the BLM State Director (USDI-BLM 2002a).

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-26. Greater Sage-Grouse Leks.



CHAPTER 3. AFFECTED ENVIRONMENT

The State of Wyoming contends that hunter harvest primarily consists of young birds that have a high mortality rate regardless of hunting. However, grouse harvest numbers have been reduced by shortening and moving back the hunting season dates and lowering the bag limits. These seasons were set at a later date to reduce the harvest of older, successful reproducing hens that were found with broods near water. The later season decreased the harvest of hens because the birds were scattered in all habitats. In addition, shorter seasons primarily reduce the number of hunters, since many big game seasons were underway and there is less interest in hunting sage-grouse later in September.

In order to protect greater sage-grouse breeding grounds, the BLM places a quarter-mile buffer around the edge of leks where controlled surface use (CSU) is stipulated (USDI-BLM 1990). The quarter-mile buffer around the edge of occupied or unknown status leks located on or within a quarter mile of the ARPA covers 8,124 acres or 3 percent of the ARPA. Twenty of the 88 leks in the ARPA are located on private and state lands, which are not protected in any way from disturbance. In addition, the BLM places a 2-mile lek buffer in a seasonal stipulation preventing disturbance to protect nesting and early brood-rearing habitat. Potential greater sage-grouse nesting habitat (habitat associated with 88 leks) covers 191,017 acres or 71 percent of the ARPA. Of this acreage, 36 percent is on private and state lands.

According to Call (1974), Braun et al. (1977), Hayden-Wing et al. (1986), and others, approximately 50 percent of nests are usually located within a 2-mile radius of the strutting grounds. Using data collected at seven sites across Wyoming between 1994 and 2003, Holloran et al. (2005) documented 45 percent of nests occur within a 3-kilometer (approximately 2-mile) buffer and 64 percent of the nests occurred within a 5-kilometer (approximately a 3-mile) buffer. In addition, he also reported a correlation between nest distance from lek and success probability, suggesting increased success rates for nests greater than 8.5 kilometers from a lek (61 percent success greater than 8.5 kilometers, 44 percent success less than 8.5 kilometers). All research indicates that greater sage-grouse nest in suitable habitat beyond the 2-mile buffer. It is likely that hens from the active leks use most of the project area for nesting and brood-rearing, which in terms of suitable habitat amounts to 92 percent of the ARPA. Greater sage-grouse leks and associated nesting habitats on the project area occur mostly within the big sagebrush vegetation types. Areas with medium height sagebrush and tall residual cover of bunchgrasses provide nesting habitat (Crawford et al. 2004). Suitable brood-rearing habitat consists of various height sagebrush communities and riparian areas that provide abundant forbs, insects, and succulent mesic vegetation (Crawford et al. 2004).

Winter concentration areas have not been identified and mapped yet. Although winter conditions generally have little effect on greater sage-grouse populations (Call and Maser 1985, Beck and Braun 1978), if any winter concentration areas are identified in the future, there would be a timing restriction applied to surface disturbances and other disruptive activities to reduce stress to wintering birds from November 15 to March 14.

Severe winter relief habitat is used during the worst of winters. Severe winter relief habitat locations were located in the ARPA, covering a total of 200 acres. Twenty-six of these acres are on private lands and are not protected. Details of the protocol used in locating and describing the severe winter relief areas and results of the study are contained in a report submitted to the BLM in 2004 (HWA 2004). This study is on-going and the results will be used to identify physical and vegetative characteristics of severe winter relief habitat patches.

CHAPTER 3. AFFECTED ENVIRONMENT

Columbian Sharp-Tailed Grouse

The BLM has placed the Columbian sharp-tailed grouse on the BLM Wyoming State Director's Sensitive Species List (USDI-BLM 2002a). It is one of six sub-species of sharp-tailed grouse found in North America. In Wyoming, Oedekoven (1985) documented leks on flats or slight swales of mixed shrubland habitat. Breeding and nesting habitat consisted of herbaceous vegetation types and wintering areas were found in mixed upland shrublands and wooded riparian zones along the western edge of the Sierra Madre Range. This area partially overlaps the ARPA. Habitat types associated with the distribution of the species in the northwestern United States include sagebrush-bunch grass, meadow-steppe, mountain-shrub, and riparian zones (Giesen and Connelly 1993).

Home ranges of Columbian sharp-tailed grouse are relatively small and their activities tend to be concentrated around active leks (Oedekoven 1985). Individuals typically move up to 1 mile from an active lek for nesting, and up to 3.1 miles to wintering areas (Oedekoven 1985, Giesen and Connelly 1993). However, Columbian sharp-tailed grouse have been documented in the winter at Wild Horse Butte, which is at least ten miles from the nearest known lek. This suggests that birds may move further than 3.1 miles to wintering areas. Columbian sharp-tailed grouse lek locations were obtained from the WGFD and six leks have been documented on or within 1 mile of the ARPA, which comprise 27 percent of the leks within the BLM RFO jurisdictional area. Potential Columbian sharp-tailed grouse nesting habitat (habitat located within one mile of a lek) covers 4,956 acres or 1.8 percent of the ARPA (map M-27). Leks are not located on BLM lands, however 785 acres of nesting and brood-rearing habitat are. In order to protect Columbian sharp-tailed grouse breeding grounds, the BLM places a quarter-mile buffer around leks where CSU is stipulated (USDI-BLM 1990). It is likely that hens from the active leks use nesting and brood-rearing habitat within the ARPA. Wintering habitat for sharp-tailed grouse (serviceberry/mixed mountain shrub habitat) totals 287 acres, of which 278 acres are on BLM land.

3.7.1.4 Raptors

As indicated in the WOS (WGFD 2003a), the WYNDD (2003), and the Atlas of Birds, Mammals, Reptiles and Amphibians in Wyoming (WGFD 1999), raptor species known to occur on and near the ARPA include:

- Northern harrier (*Circus cyaneus*),
- Sharp-shinned hawk (*Accipiter striatus*),
- Cooper's hawk (*Accipiter cooperii*),
- Red-tailed hawk (*Buteo jamaicensis*),
- Swainson's hawk (*Buteo swainsoni*),
- Broad-winged hawk (*Buteo platypterus*),
- Rough-legged hawk (*Buteo lagopus*),
- Ferruginous hawk (*Buteo regalis*),
- Golden eagle (*Aquila chrysaetos*),
- Bald eagle (*Haliaeetus leucocephalus*),
- Prairie falcon (*Falco mexicanus*),
- Peregrine falcon (*Falco peregrinus*),
- American kestrel (*Falco sparverius*),
- Long-eared owl (*Asio otus*),
- Short-eared owl (*Asio flammeus*),

CHAPTER 3. AFFECTED ENVIRONMENT

- Great-horned owl (*Bubo virginianus*), and
- Burrowing owl (*Athene cunicularia*).

The topography of the ARPA includes low bluffs and cliffs that provide suitable sites for raptor nesting. The entire project area contains suitable habitat for raptor hunting or foraging.

The total number of nest sites located on and within 1 mile of the ARPA is 542 (map M-28), of which 357 nest sites are within the project boundary. The nest sites included:

- Burrowing owl (2),
- Cooper's hawk (6),
- Ferruginous hawk (132),
- Golden eagle (67),
- Great horned owl (12),
- Northern goshawk (1),
- American kestrel (7),
- Long-eared owl (1),
- Northern harrier (3),
- Prairie falcon (23),
- Red-tailed hawk (51),
- Swainson's hawk (7),
- Sharp-shinned hawk (1), and
- An unknown raptor (44).

The BLM also identified 60 additional nests that have deteriorated, are no longer present, and are classified as historical. It is possible that some of the older raptor nests in the BLM records that have not been checked for many years may have also deteriorated beyond suitable use for raptor nesting.

Inactive raptor nest sites may be used in subsequent years; therefore, all nests in good condition have the potential to be active in any given year. All raptors and their nests are protected from take or disturbance under the Migratory Bird Treaty Act (16 USC, § 703 et seq.) and Wyoming Statute (WRS 23-1-101 and 23-3-108). Golden and bald eagles are also afforded additional protection under the Bald Eagle Protection Act, amended in 1973 (16 USC, §669 et seq.).

3.7.1.5 Combinations of Wildlife Concerns

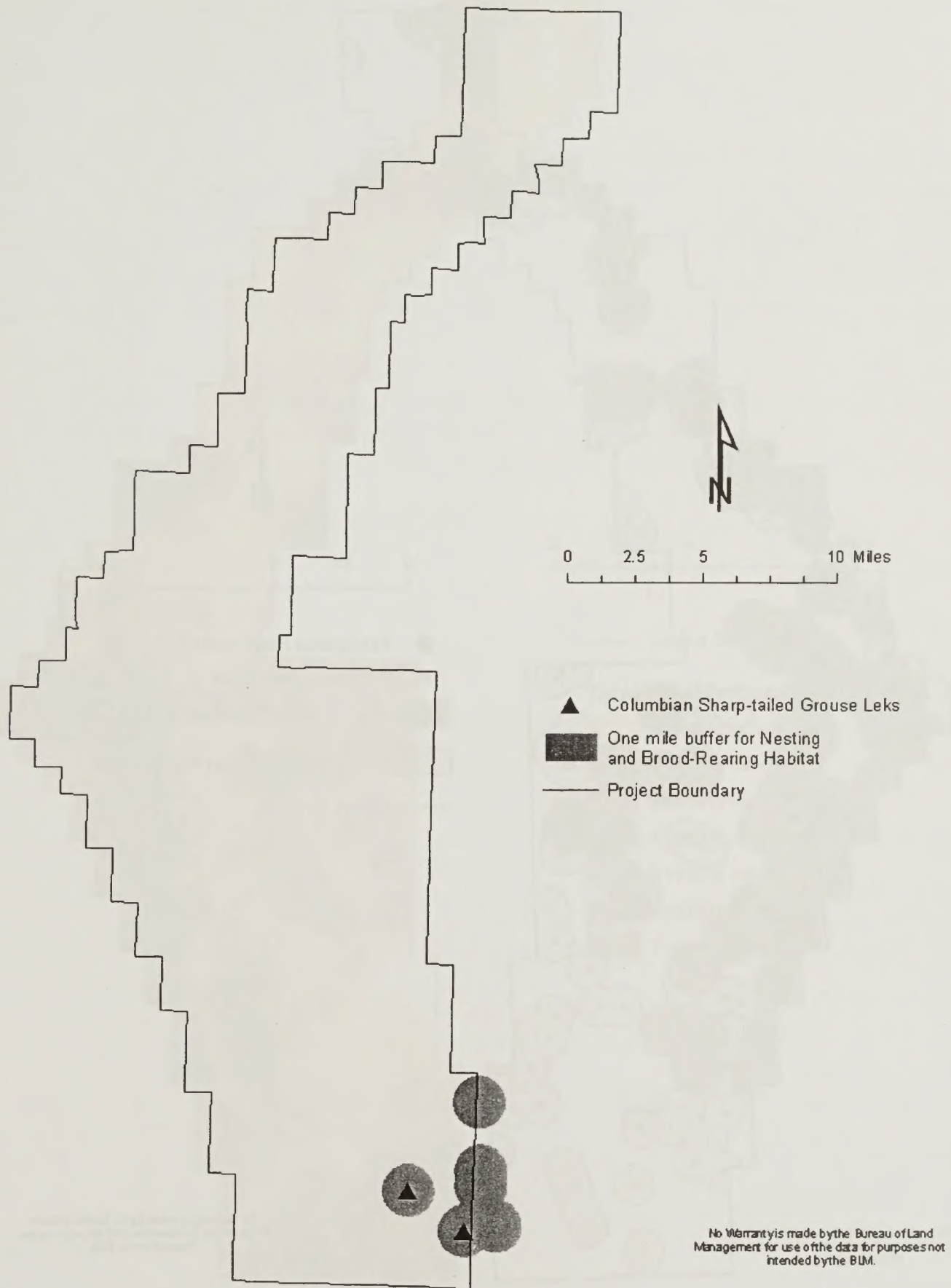
The ARPA falls entirely within the Rawlins-to-Baggs Geographical Area described in the draft Rawlins RMP (USDI-BLM 2004c). The species richness and habitat diversity in this area is one of the greatest in the RFO. The areas within the ARPA where wildlife resource concerns overlap are illustrated on map M-29. One hundred and thirteen combinations of overlapping wildlife resource concerns were identified within the ARPA. The majority (over 90 percent) of the ARPA contains at least one wildlife resource concern.

3.7.2 Fish

See section 3.8 for discussions on fish species.

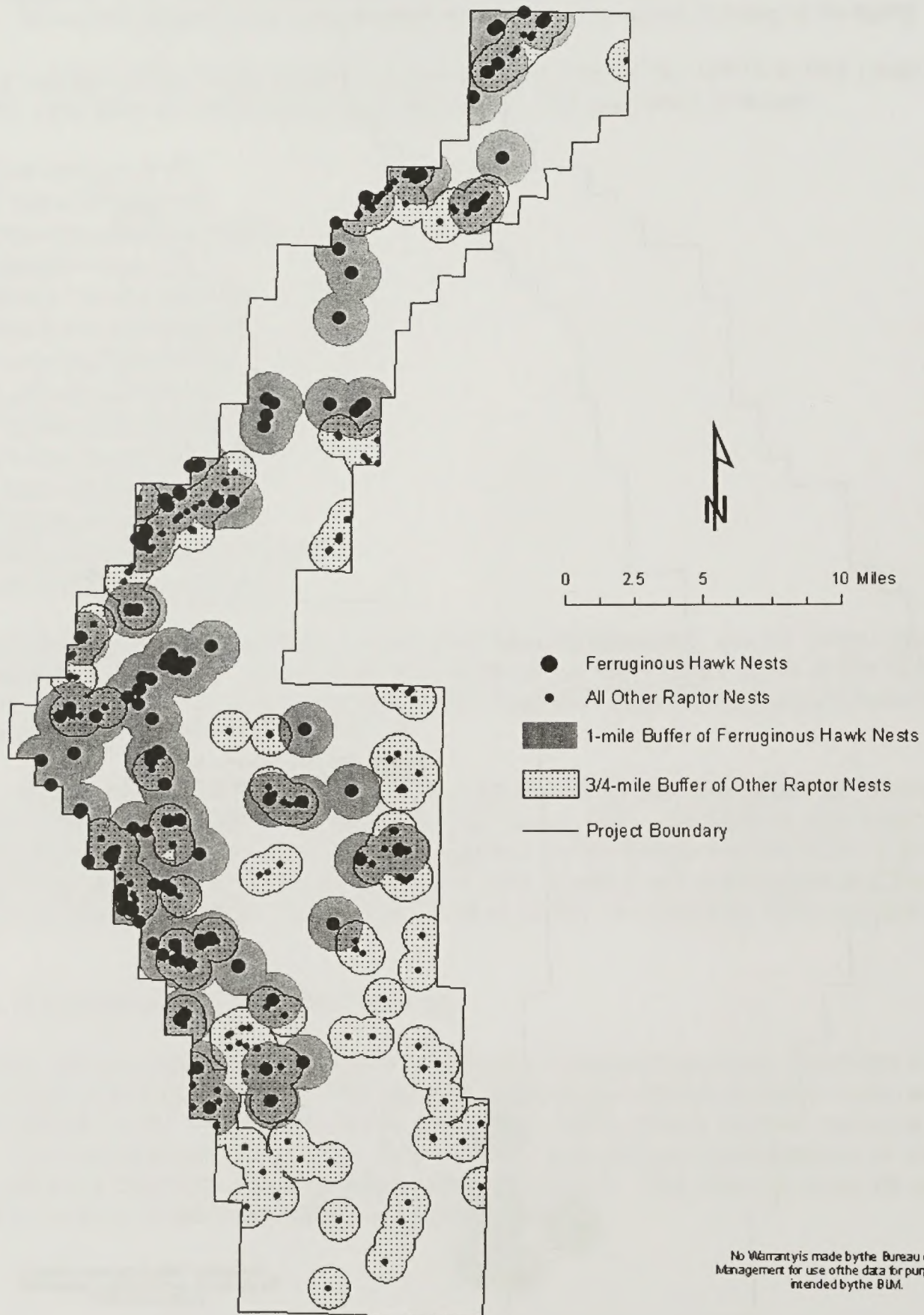
CHAPTER 3. AFFECTED ENVIRONMENT

Map M-27. Columbian Sharp-Tailed Grouse Leks Nesting and Brood-Rearing Habitat.



CHAPTER 3. AFFECTED ENVIRONMENT

Map M-28. Raptor Nest Locations.



CHAPTER 3. AFFECTED ENVIRONMENT

Map M-29. Overlapping Wildlife Concerns.



CHAPTER 3. AFFECTED ENVIRONMENT

3.8 Special Status Plant, Wildlife and Fish Species

Special status species include: (1) threatened, endangered, species proposed for listing by the USFWS (Under the ESA of 1973 as amended), and candidate species and (2) sensitive species identified by the BLM Wyoming State Sensitive Species List (USDI-BLM 2002a).

3.8.1 Threatened, Endangered, Proposed, or Candidate Species of Plants, Wildlife and Fish

The USFWS has determined that nine species, which are listed under the ESA as threatened, endangered or proposed, or as candidate or petitioned species pursuant to the ESA, are potentially present within the area administered by the BLM RFO (USDI-FWS 2004 and table 3-34). In addition, ten species that are found downstream of the area administered by the BLM RFO in the North Platte and Colorado River systems may potentially be impacted if water depletions occur. More detailed information on threatened, endangered, and proposed species is presented in the Biological Assessment (appendix G).

Table 3-34. Threatened, Endangered, Proposed, Candidate, or Petitioned Species Potentially Present within the Area Administered by the BLM RFO or That May Potentially be Impacted by the Proposed Project.

Species	Scientific Name	Status
Plants		
Blowout penstemon	<i>Penstemon haydenii</i>	Endangered
Ute-ladies'-tresses	<i>Spiranthes diluvialis</i>	Threatened
Colorado butterfly plant	<i>Gaura neomexicana</i> ssp. <i>coloradensis</i>	Threatened
Western prairie fringed orchid ¹	<i>Platanthera praeclara</i>	Threatened
Mammals		
Black-footed ferret	<i>Mustela nigripes</i>	Endangered
Canada lynx	<i>Lynx canadensis</i>	Threatened
Preble's meadow jumping mouse	<i>Zapus hudsonius preblei</i>	Threatened
Birds		
Bald eagle	<i>Haliaeetus leucocephalus</i>	Threatened
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	Candidate
Whooping crane ¹	<i>Grus americana</i>	Endangered
Interior least tern ¹	<i>Sterna antillarum</i>	Endangered
Piping plover ¹	<i>Charadrius melodus</i>	Threatened

CHAPTER 3. AFFECTED ENVIRONMENT

Table 3-34. Threatened, Endangered, Proposed, Candidate, or Petitioned Species Potentially Present within the Area Administered by the BLM RFO or That May Potentially be Impacted by the Proposed Project.

Species	Scientific Name	Status
Eskimo curlew ¹	<i>Numenius borealis</i>	Endangered
Amphibians		
Wyoming toad	<i>Bufo baxteri</i>	Endangered
Fish		
Bonytail ²	<i>Gila elegans</i>	Endangered
Colorado pikeminnow ²	<i>Ptychocheilus lucius</i>	Endangered
Humpback chub ²	<i>Gila cypha</i>	Endangered
Razorback sucker ²	<i>Xyrauchen texanus</i>	Endangered
Pallid sturgeon ¹	<i>Scaphirhynchus albus</i>	Endangered

Notes:

¹ Water depletions in the Platte River system may affect these species found downstream of the ARPA.

² Water depletions in the Colorado River system may affect these species found downstream of the ARPA.

3.8.1.1 Plant Species

No federally listed threatened, endangered, or candidate plant species are known to occur within the ARPA. However, four listed plants that may be potentially affected by the proposed action include blowout penstemon (*Penstemon haydenii*), Ute-ladies'-tresses (*Spiranthes diluvialis*), Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*), and western prairie fringed orchid (*Platanthera praeclara*) (USDI-FWS 2004).

Blowout Penstemon. Blowout penstemon, an FWS-endangered species, is known to occur in certain habitats south of the Ferris Mountains in the northern part of Carbon County. The plant has the potential to occur within the project area (Fertig 2001, USDI-FWS 2002), especially in the Sand Hills area where a few, active sand dunes are known to exist. However, the species was not found during field surveys of this area by Wyoming Natural Diversity Database (WYNDD) personnel in June 2000 (Fertig 2000).

Ute Ladies'-Tresses. The known locations of the species in Wyoming include Converse, Goshen, Laramie, and Niobrara Counties. This species is not known to occur within the ARPA and the likelihood of it occurring in the ARPA is low due to the following reasons: (1) much of the ARPA is very arid and there are few perennial streams, (2) the elevation of the project area is near the upper limit for the species, (3) very few moist riparian area meadows are present, (4) the transition from stream margins to upland vegetation is abrupt, and (5) the species has only been located in eastern and southeastern Wyoming (Fertig and Reiners 2002).

Colorado Butterfly Plant. This species is known to occur in Laramie County in southeastern Wyoming, in southwestern Nebraska, and in northeastern Colorado. This species is not known nor is it expected to occur within or near the ARPA.

CHAPTER 3. AFFECTED ENVIRONMENT

Western Prairie Fringed Orchid. This species is known to occur in Iowa, Kansas, Minnesota, Missouri, North Dakota, Nebraska, and Oklahoma as well as in Manitoba Province, Canada (NatureServe 2003). A small portion of the ARPA drains into the Platte River system and according to the USFWS, water depletions to the Platte River system may potentially affect the western prairie fringed orchid (USDI-FWS 2004); however, no depletions would occur as a result of this project.

3.8.1.2 Wildlife Species

Federally listed threatened, endangered, or candidate wildlife species potentially present with the area administered by the BLM RFO include the black-footed ferret, the Canada lynx, Preble's meadow jumping mouse, the bald eagle, yellow-billed cuckoo, whooping crane, interior least tern, piping plover, and the Eskimo curlew (table 3-34).

Black-Footed Ferret. There are no recorded sightings of black-footed ferrets within the project area (WGFD 2003a, WYNDD 2003). A total of 6,309 acres of white-tailed prairie dog colonies were identified within the ARPA (map M-30), the diet of black-footed ferrets. In addition, 115 acres of prairie dog towns connected to towns within the ARPA or towns located adjacent to the ARPA were identified. Aerial mapping and ground surveys indicated that the area and density of active prairie dog colonies may be sufficient to support black-footed ferrets and that the species could theoretically be present within the ARPA. Black-footed ferret surveys would be necessary before ground disturbing activities within prairie dog towns that meet USFWS requirements for black-footed ferret surveys (Biggins et al. 1989, USDI-FWS 1989).

Between October 2000 and October 2004, nocturnal black-footed ferret surveys were conducted on prairie dog towns located in the Dry Cow Creek Pod (HWA 2000a), Sun Dog Pod (HWA 2000b, HWA 2001a), Blue Sky Pod (HWA 2001b and HWA 2002a), and the Cow Creek Seismic Project Area (HWA 2002b) in accordance with FWS Black-Footed Survey Guidelines (USDI-FWS 1989). No black-footed ferrets or their sign were observed during the surveys.

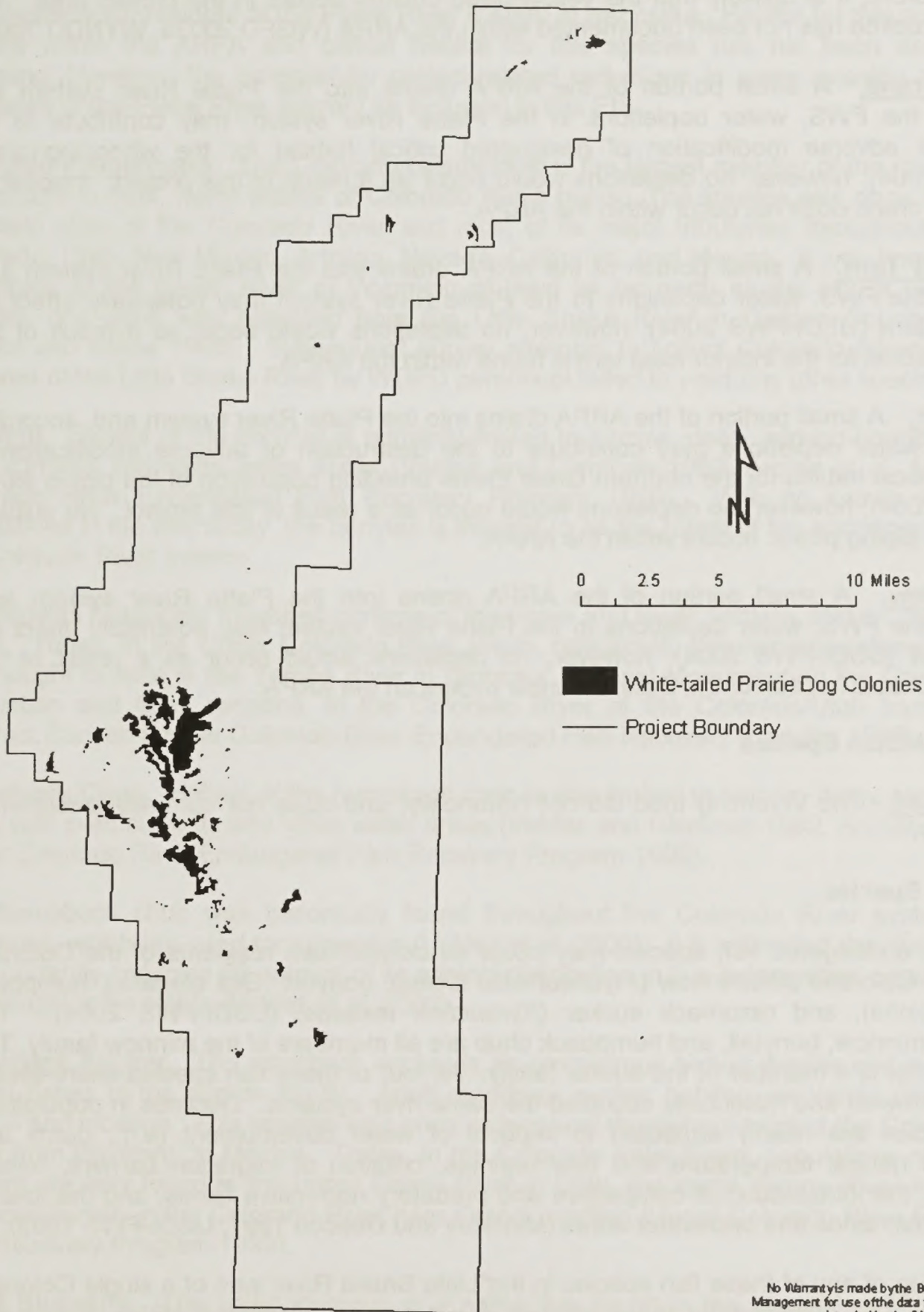
Canada Lynx. Although Wyoming comprises part of the species' historic geographical range, no lynx sightings have been documented in the ARPA or within a 6-mile buffer (WGFD 2003a). In a collaborative effort, the BLM and WYNDD completed a lynx habitat suitability map for the State of Wyoming (Beauvais et al. 2001), according to which lands within the ARPA provide low to poor quality lynx habitat.

Preble's Meadow Jumping Mouse. In Wyoming, Preble's meadow jumping mouse is found within riparian habitat corridors east of the Laramie Range Mountains and south of the North Platte River (USDI-FWS 2004). The ARPA is located more than 100 miles west of the known distribution of the Preble's meadow jumping mouse and this species is not expected to occur within the project area.

Bald Eagle. Although no bald eagle nests or nesting habitat occurs within the project area, nesting habitat does occur several miles south of the project and along the Little Snake River. Bald eagles have been observed within the project area primarily during December, January, and February (WGFD 2003a). The majority of bald eagle sightings within the project area are in the southern portion of the ARPA, close to the Little Snake River. Bald eagles may use the project area for foraging during winter months because a large portion consists of winter range for antelope, mule deer, and elk.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-30. White-Tailed Prairie Dog Colonies.



No Warranty is made by the Bureau of Land Management for use of the data for purposes not intended by the BLM.

CHAPTER 3. AFFECTED ENVIRONMENT

Yellow-Billed Cuckoo (West of the Continental Divide). Currently, the yellow-billed cuckoo west of the Continental Divide is considered a candidate species for listing under the ESA. The ARPA does not include any large riparian areas with well-developed cottonwood/riparian habitats; therefore, it is unlikely that the yellow-billed cuckoo occurs in the project area. The yellow-billed cuckoo has not been documented within the ARPA (WGFD 2003a, WYNDD 2003).

Whooping Crane. A small portion of the ARPA drains into the Platte River system and according to the FWS, water depletions in the Platte River system may contribute to the destruction or adverse modification of designated critical habitat for the whooping crane (USDI-FWS 2004); however, no depletions would occur as a result of this project. Habitat for the whooping crane does not occur within the ARPA.

Interior Least Tern. A small portion of the ARPA drains into the Platte River system and, according to the FWS, water depletions to the Platte River system may potentially affect the interior least tern (USDI-FWS 2004); however, no depletions would occur as a result of this project. No habitat for the interior least tern is found within the ARPA.

Piping Plover. A small portion of the ARPA drains into the Platte River system and, according to the FWS, water depletions may contribute to the destruction or adverse modification of designated critical habitat for the northern Great Plains breeding population of the piping plover (USDI-FWS 2004); however, no depletions would occur as a result of this project. No suitable habitat for the piping plover occurs within the ARPA.

Eskimo Curlew. A small portion of the ARPA drains into the Platte River system and, according to the FWS, water depletions to the Platte River system may potentially affect the Eskimo curlew (USDI-FWS 2004); however, no depletions would occur as a result of this project. No suitable habitat for the Eskimo curlew occurs on the ARPA.

3.8.1.3 Amphibian Species

Wyoming Toad. The Wyoming toad did not historically, and does not currently, occur in or near the ARPA.

3.8.1.4 Fish Species

Four federally endangered fish species may occur as downstream residents of the Colorado River system: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USDI-FWS 2004). The Colorado pikeminnow, bonytail, and humpback chub are all members of the minnow family. The razorback sucker is a member of the sucker family. All four of these fish species share similar habitat requirements and historically occupied the same river systems. Declines in populations of these species are mainly attributed to impacts of water development (e.g., dams and reservoirs) on natural temperature and flow regimes, creation of migration barriers, habitat fragmentation, the introduction of competitive and predatory non-native fishes, and the loss of inundated bottom lands and backwater areas (Minckley and Deacon 1991, USDI-FWS 1993).

The last sighting of any of these fish species in the Little Snake River was of a single Colorado pikeminnow in 1990. Habitat for these species is not present within the ARPA. These fish species are not likely to be found in the main stem Little Snake River and its tributaries within the ARPA. Critical habitat for these species has not been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999). However, the potential for

CHAPTER 3. AFFECTED ENVIRONMENT

project-related reductions in water quantity or quality to these tributaries to the Colorado River warrant their inclusion in this EIS.

One federally endangered fish species, the pallid sturgeon (*Scaphirhynchus albus*), may occur as a downstream resident of the Platte River system in Nebraska. Habitat for this species is not present within the ARPA and critical habitat for this species has not been designated in Wyoming. However, the potential for project-related reductions in water quantity or quality to tributaries of the Platte River warrant its inclusion in this EIS.

Colorado Pikeminnow. The Colorado pikeminnow is the largest member of the minnow family and occurs in swift, warm waters of Colorado Basin rivers. The species was once abundant in the main stem of the Colorado River and most of its major tributaries throughout Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and Mexico. It was known to occur historically in the Green River of Wyoming at least as far north as the city of Green River. In 1990, one adult was collected from the Little Snake River in Carbon County, Wyoming (Baxter and Stone 1995). Subsequent survey attempts to collect Colorado pikeminnow from this area of the Little Snake River by WGFD personnel failed to yield any other specimens.

Bonytail. Habitat of the bonytail is primarily limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the bonytail is thought to be the rarest of the endangered fishes in the Colorado River system.

The bonytail historically inhabited portions of the upper and lower portions of the Colorado River Basin. Today, in the Upper Colorado River Basin, only small, disjunct populations of bonytail are thought to exist in the Yampa River in Dinosaur National Monument, in the Green River at Desolation and Gray canyons, in the Colorado River at the Colorado/Utah border, and in Cataract Canyon (Upper Colorado River Endangered Fish Recovery Program 1999).

Humpback Chub. Habitat of the humpback chub is also limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999).

The humpback chub was historically found throughout the Colorado River system and its tributaries, which are used for spawning (Valdez et al. 2000). It is estimated that the humpback chub currently occupies 68 percent of its original distribution in five independent populations that are thought to be stable (Valdez et al. 2000).

Razorback Sucker. The razorback sucker is an omnivorous bottom feeder and is one of the largest fishes in the sucker family. Adult razorback sucker habitat use varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today, in the Colorado River Basin, populations of razorback suckers are only found in the upper Green River in Utah, the lower Yampa River in Colorado, and occasionally in the Colorado River near Grand Junction (Upper Colorado River Endangered Fish Recovery Program 1999).

Pallid Sturgeon. The pallid sturgeon is a native fish found in the Mississippi/Missouri River system. The pallid sturgeon is present in the Platte River, a tributary to the Missouri River, located downstream from a portion of the ARPA. According to the FWS, water depletions in the

CHAPTER 3. AFFECTED ENVIRONMENT

Platte River system may potentially affect the pallid sturgeon (USDI-FWS 2004); therefore, this species is included in this EIS. Suitable habitat for the pallid sturgeon consists of large turbid rivers with sand or gravel bottoms. The pallid sturgeon is threatened by habitat degradation, such as decreased turbidity, which can be caused by impoundments. There is no habitat for the pallid sturgeon located on the ARPA.

3.8.2 Sensitive Plant, Wildlife, and Fish Species

The BLM has developed a sensitive species list for public lands in Wyoming. The objective of the designation is to ensure the overall welfare of these species is considered when undertaking actions on public land and that those actions do not contribute to the need to list the species under the provisions of the ESA. The BLM Sensitive Species List is meant to be dynamic and is reviewed annually with recommendations from BLM and appropriate non-BLM authorities for additions and deletions (USDI-BLM 2002a). The species listed on the BLM Sensitive Species List that occur within in the area managed by the BLM RFO are given in this section. These species may occur within or near the ARPA.

3.8.2.1 Sensitive Plant Species

Eight plant species of special concern may potentially occur within or near the area managed by the BLM RFO (USDI-BLM 2002a); However, none of these species have known occurrences within the project area (WYNDD 2003). Suitable habitats for four of the eight species are absent in the ARPA and four have the potential to occur. The names, sensitivity status, and probability of occurrence of these species are listed in table 3-35.

Nelson's Milkvetch. This plant is a regional endemic of southwest and central Wyoming, northeast Utah, and northwest Colorado. The known Wyoming occurrences are found in sparsely vegetated sagebrush and juniper communities. This plant has the potential to occur within the project area; however, the species has not been found within the ARPA.

Gibben's Beardtongue. In Wyoming, the known occurrences of Gibben's beardtongue are confined to extreme southwestern Carbon County and extreme southeastern Sweetwater County near the state line. This plant has the potential to occur within the project area; however, the species has not been found within the ARPA.

Pale Blue-Eyed Grass. In Wyoming, the plant is known from the Laramie, North Platte, and Great Divide Basins in Albany and Carbon Counties. This plant has the potential to occur within the project area; however, the species has not been found within the ARPA.

Laramie False Sagebrush. The species is endemic to southeastern Wyoming (Albany and Carbon Counties) but has also been reported in Converse and Natrona Counties. This species has not been found and is not expected to occur within or near the ARPA.

Laramie Columbine. Laramie columbine is found within crevices of granite boulders and cliffs. This species has not been found and is not expected to occur in or near the ARPA.

Cedar Rim Thistle. Cedar Rim Thistle is endemic to the Wind River and Green River Basins of central Wyoming. This plant has the potential to occur within the project area; however, the species has not been found within the ARPA.

CHAPTER 3. AFFECTED ENVIRONMENT

Weber's Scarlet Gilia. This species has not been found and is not expected to occur in or near the ARPA.

Persistent Sepal Yellowcress. This species has not been found and is not expected to occur in or near the ARPA.

Table 3-35. Sensitive Plant Species with Potential to Occur On or Near the Atlantic Rim Project Area.

Common Name	Scientific Name	Status ¹	Habitat	OP ²
Laramie columbine	<i>Aquilegia laramiensis</i>	G2/S2, FSR2	Crevices of granite boulders and cliffs 5400 to 8000'	N
Nelson's milkvetch	<i>Astragalus nelsonianus</i>	G3/S3	Alkaline clay flats, shale bluffs, pebbly slopes and volcanic cinders in sparsely vegetated sagebrush, juniper & barren clay slopes 6,500 to 8,200'	P
Cedar Rim Thistle	<i>Cirsium aridum</i>	G2Q/S2	Barren, chalky hills, gravelly slopes, and fine textured, sandy-shaley draws 6700 to 7200'	P
Weber's Scarlet Gilia	<i>Ipomopsis aggregata ssp. weberi</i>	G5T1T2 Q/S1, FSR2	Openings in conifer forests and scrub oak woodlands 8500 to 9600'	N
Gibben's beardtongue	<i>Penstemon gibbensii</i>	G1/S1	Barren south-facing slopes on loose sandy-clay derived from Brown's Park formation; may occur in grass-dominated sites with scattered shrubs; semi-barren fringed sagebrush/thickspike wheatgrass communities with 15-20% vegetation cover, or ashy slopes amid <i>Cercocarpus montanus</i> ; may also occur on outcrops of Green River Formation on steep yellowish sandstone-shale slopes below caprock edges.	P
Persistent sepal yellowcress	<i>Rorippia calycina</i>	G3/S2S3	River banks and shorelines, usually on sandy soils near high water line	N
Pale blue-eyed grass	<i>Sisyrinchium pallidum</i>	G2G3/S2S3	Wet meadows, stream banks, roadside ditches & irrigated meadows 7,000 to 7,900'	P
Laramie false sagebrush	<i>Sphaeromeria simplex</i>	G2/S2	Cushion plant communities on rocky limestone ridges & gentle slopes 7,500 to 8,600'	N

Sources: USDI-BLM (2002a), WYNDD (2003).

Notes:

¹ Definition of status

G- Global rank: rank refers to the range-wide status of a species.

T - Trinomial rank: rank refers to the range-wide status of a subspecies or variety.

S - State rank: rank refers to the status of the taxon (species or subspecies) in Wyoming. State ranks differ from state to state.

1 - Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.

2 - Imperiled because of rarity (often known from 6-20 occurrences) or because of factors demonstrably making a species vulnerable to extinction.

3 - Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).

4 - Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.

5 - Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.

? - Questions exist regarding the assigned G, T, or S rank of a taxon.

² OP - occurrence potential: P - potential, N - not potential

CHAPTER 3. AFFECTED ENVIRONMENT

3.8.2.2 Sensitive Wildlife Species

Twenty-eight sensitive wildlife species may potentially occur within or near the area managed by the BLM RFO (USDI-BLM 2002a). Eleven of these species have been observed within the project area: the white-faced ibis, ferruginous hawk, peregrine falcon, greater sage-grouse, Columbian sharp-tailed grouse, mountain plover, long-billed curlew, burrowing owl, sage thrasher, loggerhead shrike, and Brewer's sparrow.

Long-Eared Myotis. Although this species may hibernate in Wyoming, its residency status is currently unknown and it is thought to be uncommon (WGFD 1999). Although a limited amount of sparse juniper woodland occurs on the ARPA, sightings of the species have not been documented and it is unlikely to occur there.

Fringed Myotis. The fringed myotis occupies a variety of desert, grassland, and woodland habitats throughout western North America from British Columbia to southern Mexico. The fringed myotis has been observed to the northeast, east, and west of the project area (WGFD 1999). It could potentially occur in the ARPA to feed, but hibernation is unlikely because of the lack of suitable habitat.

Spotted Bat. This bat occurs sporadically across the western United States and has not been documented within the ARPA, but it may occur.

Townsend's Big-Eared Bat. This bat can be found throughout Wyoming and its distribution is likely determined by the availability of roosts, such as caves, mines, tunnels, and crevices with suitable temperatures (Clark and Stromberg 1987). The Townsend's big-eared bat has been observed to the north, east, and west of the ARPA (WGFD 1999). It may occur in the project area to feed, but is unlikely to roost there because of the lack of suitable habitat.

Pygmy Rabbit. This rabbit inhabits areas eight western states and has been documented in Sweetwater County, Wyoming. It prefers tall sagebrush and deep, soft soil for burrowing. It has the potential to occur in the ARPA.

White-Tailed Prairie Dog. White-tailed prairie dogs occupy the grass, shrub-grass, and desert-grass habitats in the western half of Wyoming (Clark and Stromberg 1987). White-tailed prairie dog towns were mapped on the ARPA. Collectively, a total of 6,309 acres of white-tailed prairie dog colonies were identified within the ARPA (map M-30). In addition, 115 acres of prairie dog towns connected or adjacent to towns within the ARPA were identified.

Black-Tailed Prairie Dog. Black-tailed prairie dogs occupy the grass, shrub-grass, and desert-grass habitats in the northern and eastern Wyoming. This species has not been found and is not expected to occur in or near the ARPA.

Wyoming Pocket Gopher. The Wyoming pocket gopher is endemic to southeastern Sweetwater County and southwestern Carbon County. Populations in Carbon County are known only from Bridger's Pass but may occur elsewhere (Clark and Stromberg 1987). Based on the known distribution of the species and the availability of suitable habitat, Wyoming pocket-gophers likely occur in the ARPA.

Swift Fox. The swift fox inhabits short grass and mid-grass prairies over most of the Great Plains including eastern Wyoming (Clark and Stromberg 1987). Woolley et al. (1995) studies have documented occurrences in Carbon and Sweetwater Counties; however, no swift fox were

CHAPTER 3. AFFECTED ENVIRONMENT

found during his survey in southwestern Carbon County. Swift foxes may potentially occur within the project area.

White-Faced Ibis. White-faced ibis have been documented within the project area.

Trumpeter Swan. In Wyoming, the trumpeter swan is an uncommon resident (WGFD 1999) and the majority inhabit the Yellowstone National Park region. Trumpeter swans have been observed to the east and to the north of the ARPA (WGFD 2003a), but suitable habitat does not occur within the ARPA.

Northern Goshawk. Northern goshawks are known to occur adjacent to the ARPA (WGFD 2003a).

Ferruginous Hawk. The ferruginous hawk is a common species in south-central Wyoming and is known to occur and nest within the project area.

Peregrine Falcon. Bird populations in and around the project area may be abundant and diverse enough to support peregrines. Peregrine falcons may at times migrate through the project area, but nesting by this species in or near the project area is unlikely due to the lack of cliffs high enough to provide suitable nesting habitat. Peregrine falcons have been observed in the ARPA (WGFD 2003a).

Greater Sage-Grouse. The greater sage-grouse has been observed within the project area. See section 3.7.3.1 for a summary.

Columbian Sharp-Tailed Grouse. The Columbian sharp-tailed grouse has been observed within the project area. See section 3.7.3.2 for a summary.

Mountain Plover. Observations of mountain plovers within and adjacent to the ARPA have been recorded by the WGFD (2003a) and BLM wildlife biologists.

Long-Billed Curlew. Three observations of this species have been recorded approximately 2 miles northeast of the ARPA and one observation in the east-central portion of the ARPA (WGFD 2003a).

Yellow-Billed Cuckoo (East of the Continental Divide). The last record of a yellow-billed cuckoo being detected on a Breeding Bird Survey route in Wyoming was from 1995 (USGS 2004). The ARPA does not include any large riparian areas with well-developed cottonwood/riparian habitats; therefore it is unlikely that the yellow-billed cuckoo occurs in the project area; it has not been documented within the ARPA (WGFD 2003a, WYNDD 2003).

Burrowing Owl. Burrowing owls are known to occur and nest on the ARPA (WGFD 2003a).

Sage Thrasher. This bird is considered a sagebrush obligate and is generally dependent on large patches and expanses of sagebrush steppe for successful breeding. Sage thrashers have been observed throughout Wyoming, including within the ARPA (WGFD 2003a).

Loggerhead Shrike. In Wyoming, loggerhead shrike is a common summer resident and may be a year-round resident in the southern half of the state. Loggerhead shrikes have been observed within the ARPA (WGFD 2003a).

CHAPTER 3. AFFECTED ENVIRONMENT

Brewer's Sparrow. The Brewer's sparrow breeds in landscapes dominated by big sagebrush throughout the Great Basin and intermountain West and winters in sagebrush shrublands and brush desert habitat in the southwestern United States and northern Mexico (Rotenberry et al. 1999). According to the WGFD (2003a), Brewer's sparrow is known to occur in the ARPA.

Sage Sparrow. The sage sparrow breeds in sagebrush expanses from the northern edges of the Great Basin west of the Rocky Mountains to the chaparral and sagebrush scrub in Baja California (Martin and Carlson 1998). Sage sparrows are known to occur throughout the ARPA (WGFD 2003a).

Baird's Sparrow. Based on the distribution of this species and its preferred habitat, it is unlikely that it would occur in the ARPA during the breeding season, but may occur as a summer resident (WGFD 1999) or during migration (Johnsgard 1986) to wintering sites (DeGraaf et al. 1991). Two observations of Baird's sparrow were recorded by the WGFD approximately 2 miles northeast of the ARPA in 1981 (WGFD 2003a).

Northern Leopard Frog. A member of the true frog family (*Ranidae*), the northern leopard frog is an obligate of permanent water in the plains, foothills, and montane zones. Sightings of this species have been documented in all counties of Wyoming and this species has a high probability of occurring in any areas of the ARPA having perennial water (WYNDD 2003).

Great Basin Spadefoot. Sightings of this species have been documented in Sweetwater, Lincoln, Fremont, and Natrona counties of Wyoming (Baxter and Stone 1992). The known distribution of the Great Basin spadefoot is west of the ARPA. No observations have been reported in the WOS (WGFD 2003a) near the ARPA. The Wyoming Species Atlas (WGFD 1999) indicates that the species' range encompasses the ARPA; however, the species is unlikely to be found within the project area.

Western Boreal Toad. The range for boreal toads is thought to encompass the Muddy Creek watershed (Baxter and Stone 1992). However, no sightings of this species within 6 miles of the project area have been reported in the WOS (WGFD 2003a). It appears that habitat within the majority of the ARPA is too arid for this species to persist and thrive, but it may occur in isolated areas where habitat is suitable.

3.8.2.3 Sensitive Fish Species

Fish species that are not listed as endangered or threatened by the FWS, but may be rare or declining within the state, have been included on the BLM Wyoming Sensitive Species List (USDI-BLM 2002a). The intent of the sensitive species status is to ensure that actions on BLM-administered lands consider the welfare of these species and do not contribute to the need to list any other species under the provisions of the ESA (USDI-BLM 2002a).

Four BLM Wyoming state sensitive fish species are known to occur in portions of streams within or adjacent to the ARPA. These include the roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) (WYNDD 2003, USDI-BLM 2002a). The three warm water fish species (roundtail chub, bluehead sucker, flannelmouth sucker) can be found within the Muddy Creek watershed downstream of the ARPA (Beatty 2005), within the ARPA, and upstream of the ARPA (WGFD 1998, 2004b; Bower 2005). The BLM and WGFD are signatory to the Range-wide Conservation Agreement for Roundtail Chub, *Gila robusta*,

CHAPTER 3. AFFECTED ENVIRONMENT

Bluehead Sucker, *Catostomus discobolus*, and Flannelmouth Sucker, *Catostomus latipinnis*. This agreement establishes the BLM's commitment to implement conservation strategies developed at both the range-wide and state-wide scales for these three species. The range-wide conservation strategy for these species identifies the enhancement and maintenance of habitat for roundtail chubs, bluehead suckers, and flannelmouth suckers as a conservation priority.

The BLM, WGFD, and the University of Wyoming have recently completed two studies to characterize the abundance, distribution, ecology, habitat requirements, and genetics of the three native warm water fish species within the Muddy Creek watershed (Beatty 2005, Bower 2005). Additional studies are underway to characterize the movement patterns of the three species within and upstream of the ARPA within the upper Muddy Creek watershed. Results obtained through 2005 have indicated that these isolated populations may represent one of the highest conservation priorities for native fishes within Wyoming (Beatty 2005, Bower 2005).

The Colorado River cutthroat trout, which is a native coldwater game fish, has been re-introduced into Muddy Creek upstream of the ARPA and Littlefield Creek, a tributary to Muddy Creek, upstream of the ARPA. Before the introduction was made, all fish in these segments of these creeks were eliminated and a fish barrier was installed on Muddy Creek, immediately upstream of McKinney Creek, to prevent non-native fish from gaining access to the stream. In addition to the Colorado River cutthroat trout, the WGFD is planning to re-introduce all native species into the segment of Muddy Creek upstream of the fish barrier. Colorado River cutthroat trout also occur upstream from the project area in the Little Snake River (Baxter and Stone 1995). This species has been petitioned for listing as threatened or endangered.

Besides Muddy Creek, the majority of other streams on the ARPA are ephemeral and, therefore, do not have the potential to support BLM Wyoming state sensitive fish species on a year-round basis. Studies indicate that the native warm water species may ascend ephemeral tributary streams to spawn (USDI-FWS 1985, Maddux and Kepner 1988, Weiss et al. 1998). Thus, ephemeral drainages fed by runoff from the project area may provide habitat for sensitive fish on a seasonal basis.

Roundtail Chub. This species is found within the Green River drainage including portions of the Little Snake River drainage and can be found in the Muddy Creek watershed, Carbon County, Wyoming. Roundtail chubs occurring downstream (Beatty 2005), within, and upstream of the ARPA within the Muddy Creek watershed represent the most abundant population of this species known from within Wyoming (Baxter and Stone 1995, WGFD 1998, WGFD 2004b, Beatty 2005, Bower 2005). A recent status review indicated that the range of this species has been reduced roughly 55 percent from historical levels (Bezzarides and Bestgen 2002). Causes for observed declines in the distribution of roundtail chubs include construction of mainstream dams, altered river flows, and altered water temperatures (Bezzarides and Bestgen 2002).

During the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed, roundtail chubs were most abundant in areas containing deep pools and glides with rocky substrates. In addition, the abundance of roundtail chubs was positively associated with areas containing remnant pool habitats resulting from extensive stream drying (Bower 2005). Extensive movements of adult roundtail chubs have not been documented within the upper Muddy Creek watershed (Compton 2005), though movement of larvae and juveniles through

CHAPTER 3. AFFECTED ENVIRONMENT

drift has been documented in other portions of the Upper Colorado River Basin (Carter et al. 1986).

Bluehead Sucker. Bluehead suckers are present in the Little Snake, Green River, Snake, and Bear River Basins in Wyoming (Baxter and Stone 1995, WGFD 1998, WGFD 2004b). This species is found in the Muddy Creek watershed upstream, within, and downstream of the ARPA (Baxter and Stone 1995, WGFD 1998, Beatty 2005, Bower 2005). Bezzerides and Bestgen (2002) indicated that the range of this species has declined roughly 45 percent from historical levels. Causes for observed declines in distribution include construction of mainstream dams, altered river flows, and water temperatures, and hybridization with the white sucker (Bezzarides and Bestgen 2002). Bluehead suckers within the upper Muddy Creek watershed represent the most abundant population of this species known from within the Colorado River Basin of Wyoming (WGFD 2004b, Bower 2005).

Bluehead suckers were most abundant during the summer and fall of 2003 and 2004 in areas with rocky substrates (cobble-sized gravel) in close proximity to pool habitats within the upper Muddy Creek watershed. These areas are most common where pool-riffle sequences are present (Bower 2005). Extensive movements of adult bluehead suckers during the spring were observed during 2005 within the upper Muddy Creek study area, presumably in association with spawning (Compton 2005).

Flannelmouth Sucker. This species is found primarily in the Yampa, Little Snake, Colorado, Green, and Gunnison rivers and is also common in Muddy Creek in Carbon County, Wyoming, upstream, downstream, and within the ARPA (Bower 2005). Bezzarides and Bestgen (2002) indicate that the range of this species has declined roughly 50 percent from historical levels. Similar to the causes identified for the decline of other native Colorado River Basin fishes, causes for observed declines in the distribution of flannelmouth suckers include construction of mainstream dams, altered river flows and water temperatures, and hybridization with the white sucker (Bezzarides and Bestgen 2002).

Habitat features influencing the abundance of flannelmouth suckers during the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed included rocky substrates as well as deep pools and runs (Bower 2005). Movements of adult flannelmouth suckers in association with spawning have been documented within the lower Muddy Creek watershed (Beatty 2005).

Colorado River Cutthroat Trout. Colorado River cutthroat trout were the only trout native to the Green River and Little Snake River drainages in Wyoming (Baxter and Stone 1995). Historical records indicate that it was present in Muddy Creek in the mid-1800s (Fowden 2005). Historically, this subspecies inhabited clear-water tributaries of the Colorado River in Colorado, Utah, Wyoming, and probably also in New Mexico and Arizona (Behnke 1992). This species now occupies only a fraction of its former range. Some of the most genetically "pure" of the remaining populations of this trout subspecies are found in the Little Snake River upstream of the ARPA in Carbon County, Wyoming (Baxter and Stone 1995).

Colorado River cutthroat trout have been reintroduced into Littlefield Creek and Muddy Creek upstream of the ARPA. The species is generally associated with steep, clear, cold-water streams around rocky areas, riffles, deep pools, and near or under overhanging banks and logs (Binns 1977). Colorado River cutthroat trout have been extirpated from much of their original range through competition with brook trout, rainbow trout, and brown trout, and hybridization with rainbow trout (Binns 1977). Though reintroduced populations exist in close proximity

CHAPTER 3. AFFECTED ENVIRONMENT

upstream of the ARPA, habitats within and downstream of the ARPA are generally supportive of warm water, not coldwater fishes. Therefore, this species is unlikely to occur within the ARPA.

3.9 Recreation Resources

Hunting is the main recreation use in the ARPA. The Baggs Herd Unit of mule deer, in the southern half of the ARPA, is one of the most heavily hunted in the state. Hunters also pursue antelope and elk as well as small game and upland birds. The ARPA attracts recreation visitors driving for pleasure and viewing wildlife. Recreational camping and off-highway vehicle (OHV) use occurs primarily as part of hunting and related activities, such as scouting game. Hunting is described in section 3.9.1.1.

Although there are no counts of recreational visits to the ARPA, overall use is believed to be low, except during and just before hunting season, which occurs primarily in the fall (USDI-BLM 2000a). Low visitation during the rest of the year is due to low population densities in proximity to the area and the historically seasonal nature of the road network. Snowdrifts in winter and rains the rest of the year have made most of the roads intermittently impassable until recent improvements in surfacing on BLM and County Roads. Visitation within the ARPA may increase in response to road improvements. The Sand Hills ACEC, about 8,300 acres located within the ARPA, is managed to protect vegetation and wildlife habitat and is a particularly important deer hunting area because of its unique vegetation complex. Vegetation in the area is still recovering from a fire in the early 1990s.

Visitation is also expected to increase with the stabilization and interpretation of the JO Ranch that was recently acquired in a land exchange near the Sand Hills. The Continental Divide National Scenic Trail (CDNST) is within 3 miles of the northeastern boundary of the ARPA, but it is not likely to affect visitation within the project area.

3.9.1 Recreation Resources and Use

The principal recreation resources of the ARPA are the public lands managed by the BLM. This section discusses their use primarily for hunting and secondarily for pleasure driving and wildlife viewing. There are several fishing resources in the ARPA.

The BLM does not measure recreation use in the jurisdiction of the BLM RFO, including the ARPA, so counts of non-hunting recreation are not available. However, BLM personnel have observed that recreational use in the RFO Management Area in general appears to be steady or in a slight upward trend. If favorable conditions for wildlife are sustained in the future, then hunting throughout the RFO Management Area, and similarly within the ARPA, is likely to continue near current levels. A network of many small roads and two-tracks covers the area within the jurisdiction of the BLM RFO, including the ARPA, connecting more remote locations to the larger collector roads. These routes are used for recreational purposes, as well as for access to develop and maintain oil and gas wells and range improvements. The road network includes roads maintained by the BLM, counties, and private corporations. Whether improved or not, roads and two-tracks facilitate dispersed recreation and can be expected to affect the potential for dispersed recreation use in the future.

CHAPTER 3. AFFECTED ENVIRONMENT

3.9.1.1 Hunting

Big game habitat is found throughout the ARPA (See section 3.7.2). The ARPA attracts hunters for mule deer in particular, but also for elk, antelope, sage-grouse, and cottontail rabbit. The area is dry and lacks large water impoundments, so waterfowl hunting is minimal. Most big and small game hunting occurs on BLM land, with some occurring on private land by permission of the landowner or with outfitters and guides by commercial lease.

Hunting camps are often grouped near the Sand Hills, Cow Creek Butte, Lone Butte, and Five Buttes areas. Other camps are dispersed throughout the hunt areas that include the ARPA. Motels are typically fully booked during hunting season with state residents as well as non-residents who do day trips to hunt. Many other hunters in the ARPA live in Rawlins, Wamsutter or Baggs, Wyoming.

Table 3-36 presents data on hunting activity that indicate the level of hunting potentially occurring within the ARPA. Hunting data are available only as totals for the hunt areas delineated by the WGFD. Data in the table are the totals for the hunt areas that include the ARPA because information is not available for smaller areas within the hunt areas (Woolley 2003). The ARPA is a significant portion of these hunt areas. The area covered by the hunt areas generally extends from I-80 south to the Wyoming-Colorado border and from Wyoming State Highway 789 east to highway 71 and the Continental Divide in the Medicine Bow National Forest. The areas include land in a variety of ownerships and a range of types and quality of huntable habitat.

Table 3-36. Indicators of Hunting Activity by Species in the WGFD Hunt Areas that Include the ARPA, 2002.

Game Species	Hunt Areas Involved	Total Active Hunters	Average Non-Resident Hunters	Average Hunter Success	Average Days per Hunter	Number of BLM-Permitted Commercial Outfitters
Mule Deer	82 Baggs, 84 Atlantic Rim	2,784	40%	54%	8.0	13 5
Antelope	53 Baggs, 55 Red Rim	377	21%	99%	2.9	9 4
Elk	21 Baggs, 108 South Rawlins	3,532	11%	45%	12.3	13 2
Birds & Small Game ¹	25 Sierra Madre	509	NA	NA	2.5	NA

Notes:

¹ About 51 percent sage-grouse hunting and 47 percent cottontail rabbit. The remainder is dove hunting. Individual hunters may hunt more than one species. Seasons may overlap.

NA - Data not available.

Averages are weighted averages based on the proportion of active hunters in each hunt area.

Waterfowl hunting is minimal in the ARPA.

Source: <http://gf.state.wy.us/wildlife/hunting/stats/harvest/200x/index.asp>

Two mule deer hunt areas overlap the ARPA. Hunt Area 84 overlaps the ARPA north of Muddy Creek and Hunt Area 82 overlaps the ARPA south of Muddy Creek. The ARPA includes about 37 percent of the total area of Hunt Areas 82 and 84 combined. In 2002, Hunt Area 82, the

CHAPTER 3. AFFECTED ENVIRONMENT

Baggs hunt area, was third in Wyoming in the estimated total number of deer hunters for the season and third in estimated hunters hunting on opening day. The estimate of the ARPA's share of the two hunt areas is based on a visual inspection of area maps by Lloyd Levy Consulting LLC. The hunting data are from the WGFD's (2002) Deer Harvest Report, with analysis by Lloyd Levy Consulting LLC for the BLM.

Hunting seasons in the ARPA are in the early fall through winter. Mule deer, elk, antelope, and sage-grouse are generally hunted from September through November. Rabbits and predators are hunted in late fall and winter. Most hunting in the ARPA is of local or regional importance, with many local hunters finding it convenient and economical to hunt for sport and for game meat in the area. Hunting in the ARPA is also attractive to a national clientele that finds it appealing because they can hunt multiple big game species from a single camp on a single trip to Wyoming.

The trend has been a decline in active deer hunters in hunt area 82 from between 2003 to 2005 from 2912 to 2330 active hunters. Similarly, over the same period, active elk hunters declined in hunt area 21 from 3142 to 2654. Conversely, active antelope hunters have increased from 413 to 765. This, of course, dependent on the number of hunting licenses made available by WGFD. See table 3-37 for active hunters in both hunt areas for each species.

Table 3-37. Number of Active Hunters by Species 2003-2005

Game Species	Hunt Area	2003*	2004*	2005*
Elk	21/108	3424	2762	2854
Deer	82/84	3045	2582	2473
Antelope	53/55	488	586	852

Note:

*Number of active hunters is the total of the hunt areas listed.

Source: <http://gf.state.wy.us/wildlife/hunting/stats/harvest/200x/index.asp>

3.9.1.2 Fishing

Resources for sport fishing are limited in and near the ARPA. Upper Muddy Creek, its tributaries McKinney Creek and Littlefield Creek (both outside the ARPA), and Savery Creek (outside the ARPA) are perennial streams considered to be locally to regionally important trout fisheries. About 15 reservoirs and ponds, ranging from 0.5 to 20 acres, are present within the ARPA. Four or five of these man-made impoundments, generally designed to supply water for livestock and wildlife, are stocked annually with rainbow trout by the WGFD (1998). Several reservoirs on public lands lie across Highway 789 from the ARPA.

Larger sport-fishing resources outside, but in the vicinity of, the ARPA include Rim Lake (7 miles south of Rawlins and about 4 miles east of the ARPA), Teton Reservoir (13 miles south of Rawlins and about 8 miles east of the ARPA), and the Little Snake River (2 miles south of the ARPA between Baggs and Savery). Visits to these fishing opportunities are rarely if ever related to a recreational visit to the ARPA.

The new High Savery Dam and Reservoir Project of the Wyoming Water Development Commission (about 34 miles south of Rawlins and 10 miles east of the ARPA) is now full. The fishery in the 480-acre reservoir will be managed by the WGFD for recovery of the Colorado River cutthroat trout, and recreation facilities will include a boat ramp (Hand 2004).

CHAPTER 3. AFFECTED ENVIRONMENT

3.9.1.3 Other Recreation

Besides hunting, recreationists visit the area for pleasure driving, wildlife viewing, and mountain biking. Pleasure driving occurs seasonally to view changing aspen in late September and early October. Wildlife viewing occurs primarily in the fawning season in late May and June. Raptors, sage-grouse and other birds in the ARPA attract some bird watching, and rockhounding generates a small amount of recreational use. Mountain biking occurs from spring through fall, mostly on blocked federal lands in the ARPA.

Recreational camping and OHV use, which are popular elsewhere in the RFO Management Area, occur in the ARPA primarily during hunting and preseason scouting visits. There are no developed campsites or open areas for OHV use in the ARPA. Recreational camping usually involves the use of trailers at dispersed locations primarily just before or during hunting season. OHV use is permitted only on existing roads and two-tracks, although travel off-road to retrieve a downed game animal or access a campsite is permitted. This contributes to proliferation of new two-tracks as people extend or drive off other's routes. These routes, though legal, do create erosion, habitat fragmentation and visual impacts that detract from the recreational setting.

Viewing wild horses is popular in the RFO Management Area and there is a wild horse herd in the Adobe Town Wild Horse Herd Management Area (HMA) west of highway 789, about 8 miles west of the ARPA boundary. Animals in this herd are almost entirely confined to the HMA and do not attract recreational wild horse viewers to the ARPA.

3.9.2 Recreation Plans

The BLM and Carbon County have land use planning concerns, including planning for recreational land use, that may affect the recreation resources available in the ARPA. This section reviews existing plans from these jurisdictions, focusing mainly on the BLM, which is the manager of the largest amount of land within the ARPA.

3.9.2.1 Great Divide RMP Revision

The BLM is developing a revised RMP for the RFO that will address the issue of recreation throughout the RFO Management Area, which includes the ARPA. The existing Great Divide RMP, finalized in 1990, needs to be modified because of new data, changing resource conditions, changing uses of BLM lands, and the increase in mineral activity.

The existing plan discusses BLM management actions to address several recreation resources in the ARPA or surrounding areas, including maintenance of developed recreation sites like Teton Reservoir, and planning for rehabilitation and mitigation of OHV use in specific problem areas within the Sand Hills.

JO Ranch Lands

BLM is planning to expand the Sand Hills ACEC to include the JO Ranch lands, approximately 1,234 acres in the Cow Creek Valley south of the existing Sand Hills ACEC. This planning effort could have a potential effect on recreation in the ARPA. The property has been acquired through land exchange by the BLM.

CHAPTER 3. AFFECTED ENVIRONMENT

The JO Ranch lands are generally unimproved grazing lands except for the ranch buildings. Recreational uses are primarily associated with pronghorn antelope, mule deer, elk, and sage-grouse hunting. Other than fall hunting activity, the area attracts limited numbers of recreationists engaged in back country camping and hiking, rockhounding, wildlife observation, OHV use, outdoor photography, and scenic touring. Future management of the acquired lands will be determined through additional NEPA analyses and planning.

3.9.2.2 Carbon County Land Use Plan

According to a survey in the Carbon County Land Use Plan, fishing, hunting, overnight camping, and nature appreciation are the four most important outdoor recreational activities to Carbon County residents. The plan notes that important outdoor recreational activities occur at facilities or on lands that are developed or managed by other agencies, so the plan encourages coordination to allow substantive input by the county into agency planning (Carbon County Board of Commissioners and Carbon County Planning Commission 1998). The land use plan contains no specific recreation plans for land within the ARPA.

3.10 Visual Resources

The following description of the affected environment is based on the BLM land classification program for visual resources, VRM (USDI-BLM 1980). Previous on-site visits, recent photographs, field notes compiled by other IDT members, conversations with BLM personnel, and interpretive work from topographic maps were used to characterize visual resources within the ARPA. The ARPA is characterized by diverse upland conditions interlaced with perennial and ephemeral stream systems and riparian zones.

Diversity of topography, soils, and climate creates a range of vegetation communities in the ARPA. These communities include aspen, six types of sagebrush, juniper, mountain shrub, saline desert shrub, and riparian/wetlands. The level of plant and wildlife values within the ARPA is reflected in the SMAs, Jep Canyon ACEC and the Sand Hills ACEC, which are managed for wildlife habitat.

The Atlantic Rim itself is the most distinctive landform within the ARPA. Panoramic views are seen from the crest of the Atlantic Rim and from other high points like Wild Horse Butte and Muddy Mountain. Moving generally west from the Atlantic Rim, a combination of varied topography, buttes, and sandstone outcrops subdivides the project area into a number of smaller viewsheds. Numerous small drainages dissect the landscape and add diversity.

Some of the vegetation communities within the ARPA are large, homogeneous, continuous, and relatively undisturbed tracts. They include large blocks of continuous grass, sagebrush, and tree cover, depending on elevation, soils, and water (See section 3.5).

The predominant vegetation at lower elevations of the ARPA generally changes from north to south. Beginning with sagebrush and grasses in the northernmost regions near Hogback Lake, dominant vegetation changes to sagebrush, mixed desert shrub, and forbs toward the south. It then changes to a mosaic of plant communities near Dad in the middle of the project area. Continuing southward, sagebrush dominates the landscape, giving way to large grassy-looking areas of saltbush and alkaline sagebrush south of Wild Cow Creek and southeast of Wild Horse Road. At the southernmost end of the ARPA, the rugged topography is dominated by mountain shrub and sagebrush communities.

CHAPTER 3. AFFECTED ENVIRONMENT

Juniper woodlands exist at higher elevations to the east and even more commonly in the mountainous areas of the southern ARPA. Vegetation colors in early spring are green and gray-green, changing to gray-green and buff-ochre as grasses and forbs cure in the summer and fall. Reddish brown of the Red Rim and buff colors of the sandstone outcrops add contrast and dominate in areas of steep topography.

Evidence of human modification in the ARPA includes improved and unimproved roads, power lines, constructed ponds, irrigated fields on private land in the southern part of the project area, and oil and gas production facilities. Existing disturbance from oil and gas development is about 600 acres. This disturbance—about 0.2 percent of the 270,080 total acres in the ARPA—consists of unreclaimed area from prior development of well pads, compressor stations, and containment ponds. Overall, the scenic quality of the area as seen from state, county and BLM roads is not significantly impaired by an abundance of permanent facilities.

The ARPA's visual resources are accessible to a range of users from the existing network of public roads within the ARPA. These roads are mainly Carbon County and BLM roads, with branch roads that serve existing gas development facilities. Users of the road network include private property owners, hunters, sightseers, wildlife observers and other recreationists, as well as personnel and contractors of oil and gas development operators. Some viewsheds in the ARPA are relatively inaccessible because of the private lands that are interspersed among the public lands. This condition exists primarily in the "checkerboard" part of the ARPA in Townships 17 and 18 in Range 91 where County and BLM roads are limited or do not exist (map M-4).

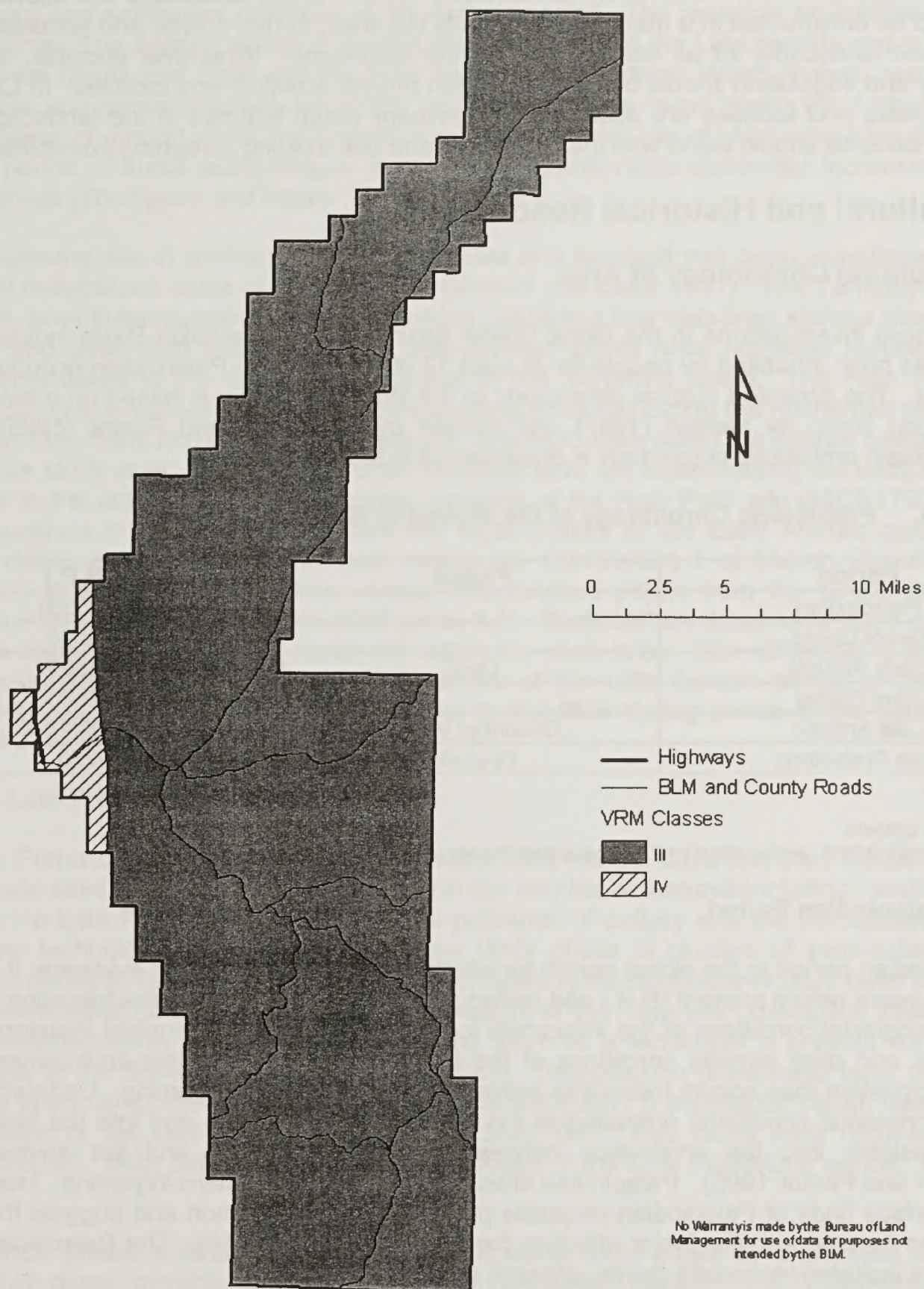
In varying degrees, parts of the ARPA are visible from WY 71/Carbon County Road (CCR) 401, WY 789, and I-80. WY 71/CCR 401 is an important access road to campgrounds in the Medicine Bow National Forest and Huston Park Wildernesses. Residents of Baggs and Dixon, Wyoming, might have views of parts of the ARPA depending on their location. Approximately 68 percent of the ARPA is visible from one or more of the state, county or BLM roads in or adjacent to the project area (map M-6).

Management of the ARPA's visual resources falls under the BLM's VRM program. The intent of the VRM program is to preserve scenic values in concert with resource development where resource development is appropriate. BLM VRM specialists have classified the ARPA as VRM Class III (approximately 96 percent of the project area) and Class IV (approximately 4 percent of the project area) (map M-31). The level of change to visual resources allowable within these two classes of landscape is described as follows (USDI-BLM 1999, Manual 8431 - Visual Resource Contrast Rating, Appendix 2):

- **Class III.** The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
- **Class IV.** The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-31. Visual Resource Management Classes.



CHAPTER 3. AFFECTED ENVIRONMENT

Thus for projects in Class III areas, project facilities, surface disturbance, and activities that contrast enough to attract viewer attention and are evident in the landscape are allowed, but they should be constructed in a manner that reflects the lines, forms, colors, and textures of the characteristic landscape, so as not to dominate the landscape. Whenever possible, existing topography and vegetation should be used to screen project activities and facilities. In Class IV areas, activities and facilities are accepted as dominant visual features in the landscape, but colors and textures should blend with the landscape and use existing screening possibilities.

3.11 Cultural and Historical Resources

3.11.1 Cultural Chronology of Area

Archaeological investigations in the Great Divide Basin and the Washakie Basin indicate that the area has been inhabited by people for at least 12,000 years from Paleoindian occupation to the present. The accepted cultural chronology of the Washakie Basin is based on a model for the Wyoming Basin by Metcalf (1987) and revised by Thompson and Pastor (1995). The Wyoming Basin prehistoric chronology is documented in table 3-38.

Table 3-38. Prehistoric Chronology of the Wyoming Basin.

Period	Phase	Age (B.P.)
Paleoindian		12,000–8500
Great Divide		8500–6500
Early Archaic	Opal	6500–4300
Pine Spring		4300–2800
Late Archaic	Deadman Wash	2800–2000/1800
Late Prehistoric	Firehole	2000-250

Notes:

B.P. = before present

Source: Metcalf (1987), as modified by Thompson and Pastor (1995)

3.11.1.1 Paleoindian Period

The Paleoindian period is the oldest period for which there is archaeological evidence. It began ca. 12,000 years before present (B.P.) and ended around 8500 B.P. This is the transition period from the periglacial conditions of the Wisconsin ice advance during the terminal Pleistocene to the warmer and drier climatic conditions of the Holocene. A savanna-like environment with higher precipitation than occurs today was prevalent in southwestern Wyoming. Understanding paleoenvironmental conditions operating at the end of the Pleistocene and into the Holocene provides insights into the articulation between human populations and the environment (Thompson and Pastor 1995). Paleoindian sites are rare in southwestern Wyoming. However, isolated surface finds of Paleoindian projectile points are not uncommon and suggest that site preservation may be a major factor affecting the number of known sites. The Paleoindian tool assemblage includes lanceolate points, graters, and end-scrapers.

3.11.1.2 Archaic Period

Settlement and subsistence practices in southwestern Wyoming remained largely unchanged from the end of the Paleoindian period through the Archaic and continued until at least the introduction of the horse or even until historic contact. Reduced precipitation and warmer

CHAPTER 3. AFFECTED ENVIRONMENT

temperatures occurred ca. 8500 B.P. The environmental change at the end of the Paleoindian period led to a pattern of broad spectrum resource exploitation, which is reflected in the subsistence and settlement practices of the Archaic period. The resource exploitation became more diverse. The Archaic period is divided into the Early and the Late periods and subdivided in the Great Divide and Opal and the Pine Spring and Deadman Wash phases, respectively. Large side- and corner-notched dart points and housepits are found during the Archaic period. The presence of ground stone implements suggests a greater use of plant resources during the Archaic period. Faunal assemblages from Archaic components document increased use of small animals (Thompson and Pastor 1995).

At the Yarmony site in northern Colorado, at least one housepit has been investigated which produced radiocarbon dates of ca. 6300 B.P. (Metcalf and Black 1991). The Yarmony housepit is a large, semi-subterranean, two-room dwelling containing four slab-lined storage bins, interior hearths, and other floor features. Large side-notched points have not been recovered from components dated to the Great Divide phase in the Wyoming Basin. The High Point site (Murray 2001) is a multi-component residential camp occupied during the Altithermal period and one of the only Early Archaic housepit sites discovered to date within the interior basin, located west of the study area. Most other Archaic housepit sites are located along the margins of the basins or in the uplifted areas. Radiocarbon analysis of the High Point site (48CR1790) places the occupations in the Great Divide and the Opal phases of the Early Archaic period. The earliest dated context for side-notched points are Component I at Maxon Ranch (6400–6000 B.P.) west of the study area. Large side-notched points from the Great Basin and Colorado Plateau occur as early as 7000 years B.P. Radiocarbon dates have been recovered from one open camp site and a burial site within the study area. Site 48CR698, a prehistoric open camp, dates to the Deadman Wash phase of the Late Archaic period at 2190 B.P. Site 48CR4001, the Cornwell Burial site, dates to the Pine Spring phase of the Late Archaic period at 3250 B.P.

3.11.1.3 Late Prehistoric Period

The Late Prehistoric period 2000-250 B.P. is subdivided into the Uinta and the Firehole phases. Large-scale seed processing and an increase in the number of features including roasting pits is noted in the Late Prehistoric period as is the presence of pottery and the introduction of bow and arrow technology. A characteristic of the Uinta phase is clusters of semi-subterranean structures dating to ca. 1500 B.P. At least two different types of structures have been identified: a more substantial, cold weather habitation is present at the Nova site (Thompson 1989); and a less substantial, warm weather structure serving more as a windbreak is present north of the study area, at the Buffalo Hump site (Harrell 1989). Radiocarbon dates have been recovered from two open camp sites in the study area. Site 48CR907, a prehistoric camp, dates to the Uinta phase of the Late Prehistoric period at 1520 B.P. Two dates were recovered from Site 48CR2785. Both dates are from the Uinta phase of the Late Prehistoric period, 1680 and 1880 B.P.

The Firehole phase is distinguished from the preceding Uinta phase by a dramatic decline in radiocarbon dates, possibly related to a decline in population density. The South Baxter Brush Shelter site (Hoefler et al. 1992) and Firehole Basin 11 site (Metcalf and Treat 1979) are sites located west of the study area attributed to the Firehole phase.

CHAPTER 3. AFFECTED ENVIRONMENT

3.11.1.4 Proto-Historic Period

The Proto-Historic period begins sometime after 300 years B.P. with the first European trade goods to reach the area and ends with the development of the Rocky Mountain fur trade 150 years ago. The Wyoming Basin was the heart of Shoshone territory during this period, with occasional forays into the area by other groups such as the Crow and Ute (Smith, A.M. 1974). The most profound influence on native cultures during this time was the introduction of the horse, which enabled Native Americans to expand their range. All forms of rock art denoting horses, metal implements, and other Euro-American goods are associated with the Proto-Historic period. These include the Upper Powder Spring Hunting Complex site west of the study area (Murcray 1993). Metal projectile points have been recovered from both surface and subsurface contexts in southwest Wyoming.

3.11.1.5 Historic Period

Historic use of the area is limited by the formidable topographic relief. Steep canyons, inadequate water supply, badlands, and escarpments make the area inhospitable for settlement, with only limited ranching activities present. Seven historic ranches have been recorded in the study area and grazing/sheepherding activities (n=21) have also been documented. Table 3-39 represents the historic chronology of the area. Fur trapping and trading was not an important occurrence in the study area due to lack of perennial streams. The Overland Trail crosses the mid-portion of the study area trending east to west. The Cherokee Trail transects the southern portion of the study area, trending east to west. The Rawlins to Baggs Road transects the center of the study area, trending northeast to southwest.

Table 3-39. Historic Chronology of the Great Divide Basin and the Washakie Basin.

Phase	Age A.D.
Proto-Historic	1720–1800
Early Historic	1800–1842
Pre-Territorial	1842–1868
Territorial	1868–1890
Expansion	1890–1920
Depression	1920–1939
Modern	1939–Present

Source: Massey 1989

3.11.2 Summary of Extant Cultural Resources

The Cultural Records Office in Laramie provided information on previous work conducted and sites recorded within the ARPA. Records at Western Archaeological Services (WAS) were consulted. There have been 315 cultural resource projects conducted and 423 sites recorded in the project area (prior to 2003). A Class III block inventory was completed in conjunction with preparation of the Atlantic Rim Environmental Assessment (Goodrick 2000). A 1,600-acre survey was conducted of the Dry Cow Creek area; two 40-acre blocks and one 10-acre block sample inventories were conducted in the Deep Creek area for a total of 90 acres; and three 40-acre blocks were sampled in the Cottonwood Creek area, for a total of 120 acres. The overall site density within the three individual blocks varied. The highest number of sites was located along drainages and near the major topographic land forms. Limited amounts of field work have resulted in the documentation of cultural resources through survey, test excavations,

CHAPTER 3. AFFECTED ENVIRONMENT

examination of ethnographic records, and historic record research. No excavations have been conducted in the ARPA.

In southwest Wyoming, sand deposits (sand shadows and sand sheets) are recognized as highly likely to contain cultural material. The topographic setting of the recently inventoried Dry Cow Creek block is conducive to prehistoric occupation. The block is bisected by Dry Cow Creek and the terrain is capped with eolian sand deposits. The topography gently slopes to the west and the south toward Dry Cow Creek, which contains limited amounts of water year round. Deep Creek and Cottonwood Creek retain limited amounts of water year round with the area surrounding the creeks characterized by rugged terrain with steep slopes dissected by deep ephemeral drainages and little soil deposition. These types of settings usually do not have high site densities. It would be more likely to encounter sites along the perennial drainages. The overall site density in the study area varies with the highest number of sites located along drainages and near the major topographic land forms. Ephemeral drainages that flow into the study area from several escarpments such as Atlantic Rim, Hogback Ridge, Wild Horse Butte, Lone Butte, China Butte, Deep Creek Butte, and Cow Creek Butte as well as Doty Mountain and Muddy Mountain, flow into the major drainages such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek and Deep Creek along with their tributaries. Numerous springs are present and would be areas likely to contain cultural resources.

There is also a potential for Native American sensitive sites or traditional cultural properties (TCP) in the study area. The definition of a TCP, according to National Register Bulletin 38 is "those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice." The traditional cultural significance of a historic property, then, is its significance derived from the role the property plays in a community's historically rooted beliefs, customs, and practices. Examples of properties possessing such significance include:

- A location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world;
- An urban neighborhood that is the traditional home of a particular cultural group that reflects its beliefs and practices;
- A location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice; and
- A location where a community has traditionally carried out economic, artistic or other cultural practices important in maintaining its historic identity.

There is also the potential for Native American rock cairns and alignments along the ridges in the study area, which do not conform to the strict definition of a TCP, but are considered sensitive nonetheless.

Two projects near the study area have investigated prehistoric site distribution and site density in the Savery Creek drainages. In Archaeological Investigations Within the Little Snake River Basin Colorado and Wyoming, Hall (1987) "reevaluated the nature and distribution of aboriginal sites" in Savery Creek, Slater Creek, Ridge and Valley geographic zones, Juniper Ridge, and the Little Snake Valley, located immediately southeast of the current study area. The Savery

CHAPTER 3. AFFECTED ENVIRONMENT

Creek investigations indicate that sites are generally located in the valley bottom or lower valley terrain, on gentle inclines, near water and near major confluences.”

In the *Class III Cultural Resource Inventory and Evaluation of Eleven Prehistoric Sites*, Latham (1999) states, “The analysis domain is characterized by non-dissected to moderately dissected uplands with mostly moderate-to-steep slopes and broad-to-narrow benches and floodplains along the many streams that pass through the area.” Most of the prehistoric sites within the analysis domain are situated on benches or ridges overlooking one of the main tributaries.

3.11.3 Site Types

Sites (n=423) recorded in the project area include: prehistoric sites (n=327), historic sites (n=69), and prehistoric/historic sites (n=27). The total percentage for site types is: prehistoric sites (77 percent), historic sites (17 percent), and sites with prehistoric and historic components (6 percent). Of the recorded cultural resources, 32 percent are recommended eligible (n=135) for nomination to the National Register of Historic Places (NRHP), 34 percent are recommended not eligible (n=145) for nomination to the NRHP, and 34 percent remain unevaluated (n=143). Table 3-40 is a summary of known cultural resources in the ARPA categorizing the sites into prehistoric open camps, prehistoric lithic debris, historic sites, and prehistoric/historic sites. Site types previously identified, recently located, or predicted to be in the ARPA are discussed below.

Three hundred twenty-seven prehistoric sites have been documented in the ARPA (before 2003). The site types include: prehistoric camps, lithic scatters, quarries, human burials, rock art, both pictographs and petroglyphs, rock alignment sites, rock shelters, stone circles, and pottery/ceramic sites.

Prehistoric camps contain evidence of a broad range of activities, including subsistence-related activities. Cultural remains include formal features such as fire hearths, stone rings, cairns, rock art, lithic debris, chipped stone tools, quarries, evidence of milling/vegetable processing activities including ground stone, and pottery. Single as well as long-term occupation may be represented.

Lithic scatters consist of sites containing lithic debris such as debitage or stone tools and quarries. No features or feature remnants are found at the site. The sites are interpreted as representing short-term activities.

Quarries are sites where lithic raw material was obtained and initially processed. Primary and secondary lithic procurement areas are geologic locations where chert and quartzite cobbles have been redeposited and later used by prehistoric inhabitants for tool manufacture. Three of the quarry sites in the project area are included in the lithic scatter sites and two are part of prehistoric camp sites.

Human burials, rock art, both pictographs and petroglyphs, rock alignment sites, and rock shelters have been identified as sensitive or sacred to Native Americans. Few of these types of sites have been located in all of southwestern Wyoming. One human burial is documented in the project area. The Cornwell Burial, Site 48CR4001, dates to the Pine Spring phase of the Late Archaic period at 3250 B.P. One petroglyph site, 48CR398, is located on the west-face of a ridge overlooking Muddy Creek. One rock shelter, 48CR1755, is located on a southwest-

CHAPTER 3. AFFECTED ENVIRONMENT

facing ridge of an ephemeral drainage of Muddy Creek. The burial and the petroglyphs are recommended eligible for inclusion on the NRHP, while the rock shelter remains unevaluated.

Table 3-40. Summary of Prehistoric and Historic Sites Located in the Atlantic Rim Project Area.

Site Eligibility					
Site Types	No. of Sites	No. of Sites Eligible	No. of Sites Not Eligible	No. of Sites Unevaluated	% of Total Sites
Prehistoric burial	1	1	0	0	
Habitation/hearths/FCR	230	97	55	78	
Prehistoric camp/ceramics	1	1	0	0	
Prehistoric rock shelter	1	1	0	0	
Prehistoric petroglyphs	1	1	0	0	
Prehistoric cairns	8	0	5	3	
Prehistoric stone circles	14	4	3	7	
Prehistoric camp/ground stone	2	2	0	0	
Prehistoric camp/quarry	2	2	0	0	
Total Prehistoric Camps	260	109	63	88	61
Lithic scatters	62	2	27	33	
Lithic scatter/ceramics	1	0	0	1	
Lithic scatter/ground stone	1	0	1	0	
Lithic scatter/quarry	3	3	0	0	
Total Lithic Debris	67	5	28	34	16
Historic trails	4	3	1	0	
Stage stations	6	5 - (1 listed)	0	1	
Historic inscriptions	1	1	0	0	
Historic cairns	3	0	2	1	
Historic debris/trash	25	1	21	3	
Historic ranches	7	0	1	6	
Irrigation ditches	1	0	1	0	
Ranching/herding/corrals debris	21	2	17	2	
Post Office	1	0	1	0	
Total Historic Sites	69	12	44	13	17
Prehistoric camp/historic debris	18	9	3	6	
Prehistoric lithic scatter/historic debris	9	0	7	2	
Total Prehistoric/Historic Sites	27	9	10	8	6
Total Sites	423	135	145	143	100

Notes:

FCR – Fire Cracked Rock

Stone circle sites have been identified in the database for the project area. The stone circle sites are generally found on ridges overlooking seasonal drainages in the project area. Prehistoric cairns are reported in the project area. The cairns are located on ridges sometimes overlooking water sources.

Pottery/ceramics are documented in the project area. Pottery is associated with the Uinta phase of the Late Prehistoric period. There are numerous pottery sites in southwestern

CHAPTER 3. AFFECTED ENVIRONMENT

Wyoming and northwestern Colorado. Pottery is associated with one lithic scatter and one prehistoric camp includes pottery.

Prehistoric/historic site types include prehistoric camp/historic debris scatters (n=18) and prehistoric lithic scatters/historic debris scatters (n=9). These multi-occupation sites exhibit mixed surface components

3.11.4 Excavation Data

No sites have been extensively tested or excavated in the project area. However, several excavations have been conducted in the surrounding area contributing data about prehistory and history of the area.

3.11.5 Historic Sites

Seventy-one historic sites have been documented in the ARPA. Site types include: historic trails, stage roads, stage stations, ranches, cairns, and debris. Three of the historic sites are linear trails/roads that cross portions of the project area. The Overland Trail (48CR932) crosses the middle portion of the study area; the Cherokee Trail (48SW3680/48CR3651) crosses the southern portion of the study area; and the Rawlins to Baggs Road (48CR3648) transects the mid-portion of the study area from a north/south direction. The Overland Trail, the Cherokee Trail, and the Rawlins to Baggs Road are recommended eligible for inclusion on the NRHP. Contributing segments of the historic routes are depicted in map M-32.

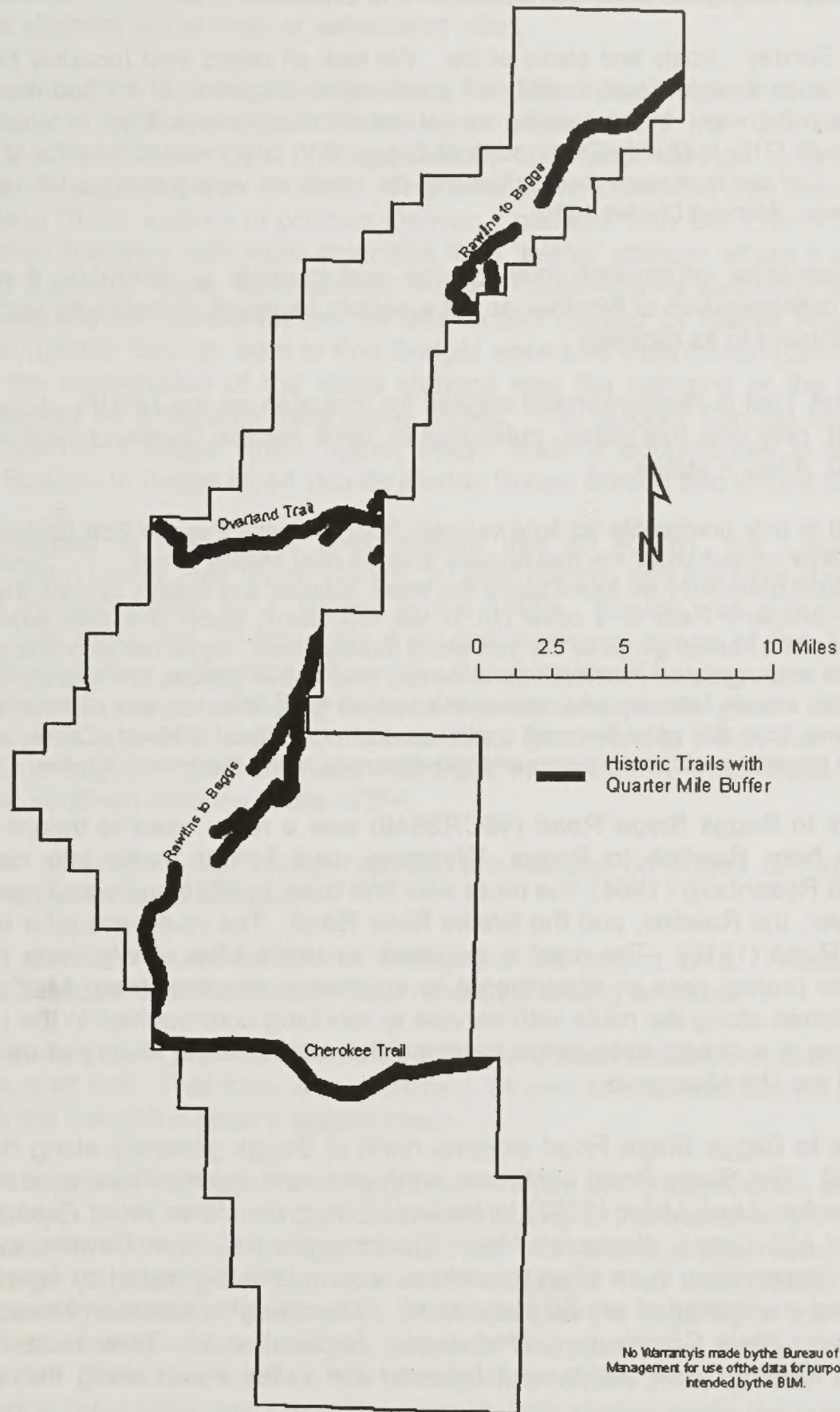
One historic road identified by the BLM on General Land Office maps is the Rawlins to Browns Hill Road. This road has not been field inspected or recorded. Historic transportation routes (i.e., trails, roads, and railroads) command a great amount of management attention because of their overall historic importance in western settlement and expansion and their pervasive presence within the ARPA.

The Cherokee Trail (48SW3680/48CR3651) was used in the 1850s by members of the Cherokee Tribe moving from the Oklahoma Reservation to the California gold fields. A southern variant of the Cherokee Trail trends southwest, crossing Savory Creek staying south of Ketchum and Five Buttes. The trail then crosses the South Fork of Cherokee Creek and then Smiley Draw, remaining south of Cherokee Creek. The road continues west, keeping Wild Horse Butte to the south, descending to the Muddy Creek drainage, and continuing west through Blue Gap Draw (map M-32). As with any of the westward migratory trails of the mid 1800s, variants have been documented. Reasons for variations in routes include inaccessibility at certain times of year or members of the group may have traveled the route previously and found an easier or more direct avenue to water.

The Cherokee Trail has received a great deal of attention by writers and even the film industry. LeRoy Hafen, in his work *The Overland Mail*, contends that the pioneering efforts of the Cherokee Indians led to the eventual development of the Overland Trail. Louis L'Amour romanticized the trail in his novel *The Cherokee Trail*. And in the 1960s a television series entitled "Cherokee Trail" drew attention to this road through southern Wyoming. The net result of the combined effort of novelists, historians, and the media has been to create a highly romanticized trail that is still not well understood in terms of the people who traveled this trail and the location of the actual route of this road taken by Cherokees traveling west from Oklahoma to California in 1850. (Gardner et al. 1999)

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-32. Historic Trails with Quarter Mile Buffer.



CHAPTER 3. AFFECTED ENVIRONMENT

Excerpts from Cherokee Trail diarist found in *Cherokee Trail Diaries* (Fletcher et al. 1999) document stops along the southern variant of the Cherokee Trail:

June 30 Sunday ...frosty and plenty of ice We took an object west (possibly Five Buttes) at a great distance west to travel to and had great trouble in getting to it Too many bluffs & bad branches in the way In the evening we got out of the mountains & got to a bad Swamp creek running south (This is Muddy Creek north of Baggs, WY) Supposed to be a for of elk head (Little Snake) 7 of our men were dissatisfied with the corse we were travling & left us taking a more South corse. (Mitchell Diaries 1850)

While supplemental information from diaries and journals is desirable, it is not required in making the determination of whether or not a certain segment of trail or its setting is contributing or not contributing to its eligibility.

The Overland Trail is recommended eligible for inclusion on the NRHP. According to Gardner et al. (1993), only one trail guide, published in 1859, for the Overland Trail is known to exist. Written by O. Allen, it states:

This road is only practicable for light vehicles from Bridger's Pass to Fort Bridger, inasmuch as heavy teams cannot cross the frail bridges erected over Muddy Creek. . . . Summit of Bridger's Pass - Good grass may be found along the water courses and valleys through the section of the country. Bridger's Pass is a deep cut in the mountains, about one mile wide and 18 long, terminating in a narrow gorge or Canyon along Muddy Creek, some twelve or thirteen miles long. This Pass is always practicable, even in winter, when other passes are entirely closed... Muddy Creek - this stream furnishes abundance of speckled trout; cherries, and currents abundant in the fruit season; from this point the road continues down the valley of Muddy Creek, and crosses the creek six times to avoid rocky points at short distances along the creek. 4 miles

The Rawlins to Baggs Stage Road (48CR3648) was a route used to freight goods, mail, and passengers from Rawlins to Baggs, Wyoming, and further south into northern Colorado. According to Rosenberg (1994), the route was first used in 1881 and was known as the Rawlins to White River, the Rawlins, and the Snake River Road. The route was later labeled the Baggs to Rawlins Road (1916). The road is depicted on Holt's Map of Wyoming (1883). The road transects the project area in a northeast to southwest direction (map M-32). Stage stations were established along the route with service to ranching communities in the Little Snake River Valley. There is a strong association between the road and the history of the Ute White River Agency and the Ute Massacre.

The Rawlins to Baggs Stage Road extends north of Baggs generally along the same route as Highway 789. The Stage Road continues north and east toward Rawlins, crossing Muddy and Dry Cow creeks. Mark Miller (1997) in *Hollow Victory: the White River Expedition of 1879 and the Battle of Milk Creek*, discusses Major Thornburgh's trek from Rawlins to the White River Agency Ute Reservation in an effort to address a complaint registered by Agent N. Meeker. His route followed a segment of an old stage road. "Thornburgh's command marched from Soldier Wells to Snake River Crossing on Wednesday, September 24. Their route crossed Dry Cow Creek, then Muddy Creek again, and followed the valley south along the west bank of the stream."

Historic trails rarely follow a single route across the landscape. Instead, numerous parallel or alternate routes may be evident as a result of travelers adjusting to specific conditions along the trails. Trail trace varies dramatically in its condition. The segments may be in original condition or may have been subject to disturbance by previous construction projects, other human

CHAPTER 3. AFFECTED ENVIRONMENT

influences (recreation or off highway travel, etc.) or natural factors including erosion. Historic trail setting is characterized as those elements of integrity of location, feeling and association that contribute to the eligibility of the trails or associated sites.

Stage stations were important to westward migration. The Washakie Stage Station (listed on the NRHP) and Sulphur Springs Stage Station were stops along the Overland Trail. Gardner et al. (1993) states "Construction of stage stations at Sulphur Springs, Washakie, and Duck Lake more than likely took place in 1862." This time frame coincides with Ben Holladay beginning his Overland Stage venture to connect Denver, Colorado, with Salt Lake City, Utah. "Home" stations offered travelers with more amenities than "swing" stations where a change of horses occurred and travelers' meals were offered. Robert Foote—giving testimony to Senator Cameron during a request for reimbursement for destruction caused by Native Americans—states "Stations from Sulphur Springs west to Fort Bridger were built from stone" (Gardner et al. 1993). Along with the construction of the stage stations was the stringing of the telegraph wires. Freighters as well as emigrants used these routes. The Sulphur Springs Station was also used by the Rawlins to Baggs Road. Other Stage Stations documented in the ARPA associated with the Rawlins to Baggs Road include Muddy Bridge Station and Willow Station.

Historic ranches recorded in the project area include the JO Ranch, the Lisco Ranch, J. Peterson Ranch, Olsen Cabin, Hay Gulch Ranch, 20 Mile Ranch, and the Pool Ranch. The JO Ranch dates to the occupation by J. Rankin in the 1890s. Rankin was a guide for the U.S. Army in 1879. He made the 28-hour ride from the besieged troops of the Thornburg Expedition to the telegraph lines in Rawlins, Wyoming. Ranching/stock herding sites in the area are generally sheepherder camps exhibiting hole-in-top cans and purple glass. Refuse left behind from tending herds is usually located on terrain with a good view to watch over the herds as well as water. One irrigation ditch has been recorded in the ARPA. The Mesa Irrigation Ditch is located in the southern reaches of the ARPA.

Historic cairns, often associated with sheep herding, are located on ridges or high points, sometimes overlooking seasonal drainages.

Historic debris/trash sites are found distributed throughout the project area. These scatters usually include trash associated with emigration and ranching/herding activities.

Studies of the three historic trails present within the ARPA have been undertaken subsequent to the completion of the draft EIS. Trail trace was examined, as well as sites that can be attributed to or associated with the use of the historic wagon roads.

A total of 60 miles of the Rawlins-Baggs Road have been studied on three separate occasions. Of those, 37.6 miles have been recommended to be contributing to the overall NRHP eligibility of the property. In addition, five historic sites associated with the road have been recommended eligible for the National Register. Eleven miles of the Overland Trail were studied for this project. All trail segments have been determined contributory to the eligibility of the property. Three individual historic sites associated with the Overland Trail have been determined eligible for the National Register. The Cherokee Trail has undergone intensive study as well. However, the status of that work is more preliminary than the other historic studies within the project area. Eighteen miles of the Cherokee Trail through the Atlantic Rim EIS area have been inventoried. Initial recommendations state that approximately 12 miles were found to contribute to the overall eligibility of the historic property. No discrete sites were identified that were associated with the trail.

CHAPTER 3. AFFECTED ENVIRONMENT

3.11.6 Summary

The subsistence and settlement patterns in the project area reflect a hunter-gatherer lifeway. Research into the subsistence and settlement patterns used during the Archaic period indicates summer occupations in the mountains, winter occupations in the foothills, and spring and fall movements using all available zones (Creasman and Thompson 1997). Subsistence patterns in the Archaic period and the Late Prehistoric period are similar in that they are based on seasonal movement throughout the basins and foothills in response to the availability of floral and faunal resources (Creasman and Thompson 1988). A wide diet breadth is evident in extensive procurement and processing of small mammals. By 450 B.P. (Shimkin 1986), or possibly earlier (Bettinger and Baumhoff 1982), Numic-speaking Shoshonean groups occupied the Wyoming Basin and continued to reside there until Euro-American expansion relegated them to reservations beginning in 1868.

Cultural resources are found along the major ephemeral drainages and along the lower benches of escarpments that dominate the terrain in the project area. Sensitive areas include drainages such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek, and Deep Creek, along with their tributaries. The numerous springs in the project area would be likely to contain cultural resources. Certain topographic settings have higher archaeological sensitivity, such as eolian deposits (sand shadows and sand sheets), alluvial deposits along major drainages, and colluvial deposits along lower slopes of ridges. A sample inventory of the three distinct blocks indicates a higher site density in the Dry Cow Creek portion where the topographic relief gently slopes toward Dry Cow Creek (Goodrick 2000). No sites were located in the central and southern portions where terrain is steeply dissected by deep ephemeral drainages. The sampling included ridges, drainages, and areas with limited sand deposits. Previous investigations along the Savery Creek drainages, east of the project area, support a higher site potential along streams.

Historic use of the project area was limited by terrain and lack of perennial water sources. Three known trails and six stage stations are located within the project area. Ranches, irrigation, grazing, and limited ranching activities are identified by the historic debris scatters and historic record.

3.12 Socioeconomics

The primary geographic area of analysis for potential socioeconomic effects of the Proposed Action and alternatives is Carbon County, Wyoming, and the communities of Baggs, Dixon, and Rawlins and the community of Wamsutter in Sweetwater County, Wyoming. Wamsutter is included because it might house some Atlantic Rim project workers.

This section characterizes these socioeconomic conditions in Carbon County: the economy and population; housing resources; community services; selected local and state government revenues; and selected attitudes, opinions, and lifestyles. Population, housing resources, and community services are also characterized for Wamsutter. Detailed information about economic, employment, and population conditions in the Rawlins Resource Area is available in the Socioeconomic Profile—Rawlins document available on the BLM's Rawlins Resource Management Plan website at:

<http://www.blm.gov/rmp/wy/rawlins/documents/RawlinsSocioeconomicProfile1-30-03.pdf>

CHAPTER 3. AFFECTED ENVIRONMENT

and in the Sonoran Institute Population, Employment, Earnings, and Personal Income Trends Profiles for Carbon and Sweetwater counties, available on the Wyoming Economic Analysis Division website at

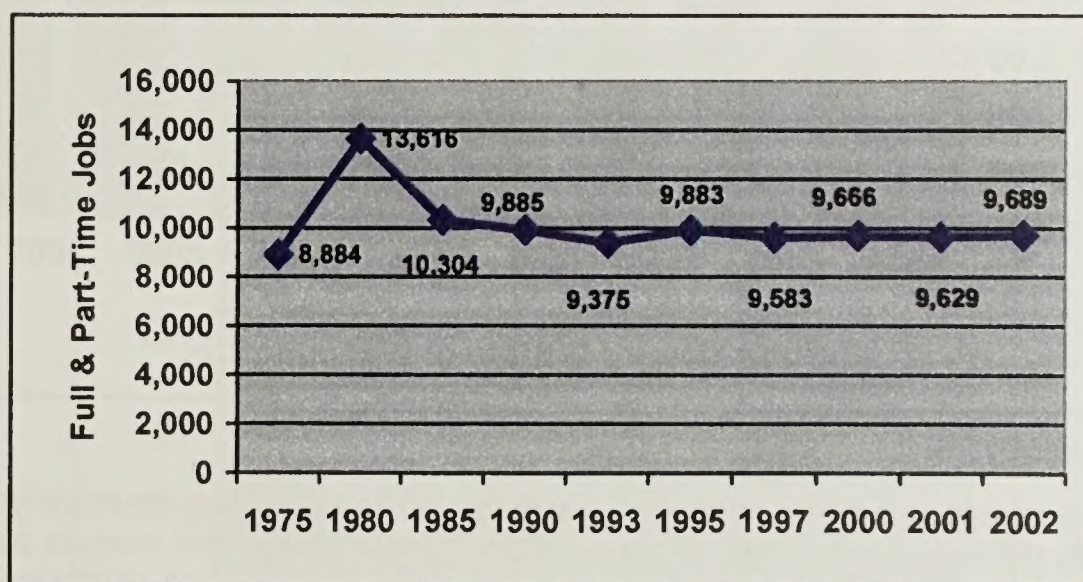
http://eadiv.state.wy.us/wef/PCarbon_WY.pdf and
http://eadiv.state.wy.us/wef/PSweetwater_WY.pdf

3.12.1 Economic Conditions

The Carbon County economy is largely based on natural resources. Basic industries that bring revenue into the county include oil and gas production and processing, coal mining, electric power generation, agriculture (primarily ranching and logging), some manufacturing, and transportation (primarily the Union Pacific railroad). Those portions of the retail and service sectors, which serve travelers, tourists, and recreation visitors, are also basic. In addition, the Carbon County economic base includes state and federal government employment; for example, the Wyoming State Prison at Rawlins is a major employer in the county.

Employment and earnings are two common measures of economic activity. As shown on figure 3-4, Carbon County full and part-time employment by place of work totaled 9,666 full- and part-time jobs in 2000, which was two percent less than the 1990 level and about 29 percent lower than the 1980 level of 13,616 jobs (WDAI 2003a). The 1980 peak reflected a period of intensive natural resource development in the petroleum and coal and uranium mining industries. Completion of infrastructure development and a weakening of commodity prices in all of these industries ushered in a period of economic and employment decline for Carbon County and for the State of Wyoming as a whole. More recently, there was some employment volatility between 1990 and 2000: the low point of 9,344 jobs occurred in 1993 and two years later, in 1995, the high point occurred with 9,883 jobs. Between 2000 and 2002, total employment has been relatively stable.

Figure 3-4. Carbon County Full- and Part-Time Employment by Place of Work: 1975–2002.



Source: WDAI 2003a

Mining sector employment, which includes direct oil and gas jobs, decreased 67 percent from 1990 to 2000, from 934 to 311 jobs; the 2000 level was 91 percent lower than the 1980 level of 3,563 mining jobs. Mining sector jobs lost another 24 percent between 2000 and 2002. The

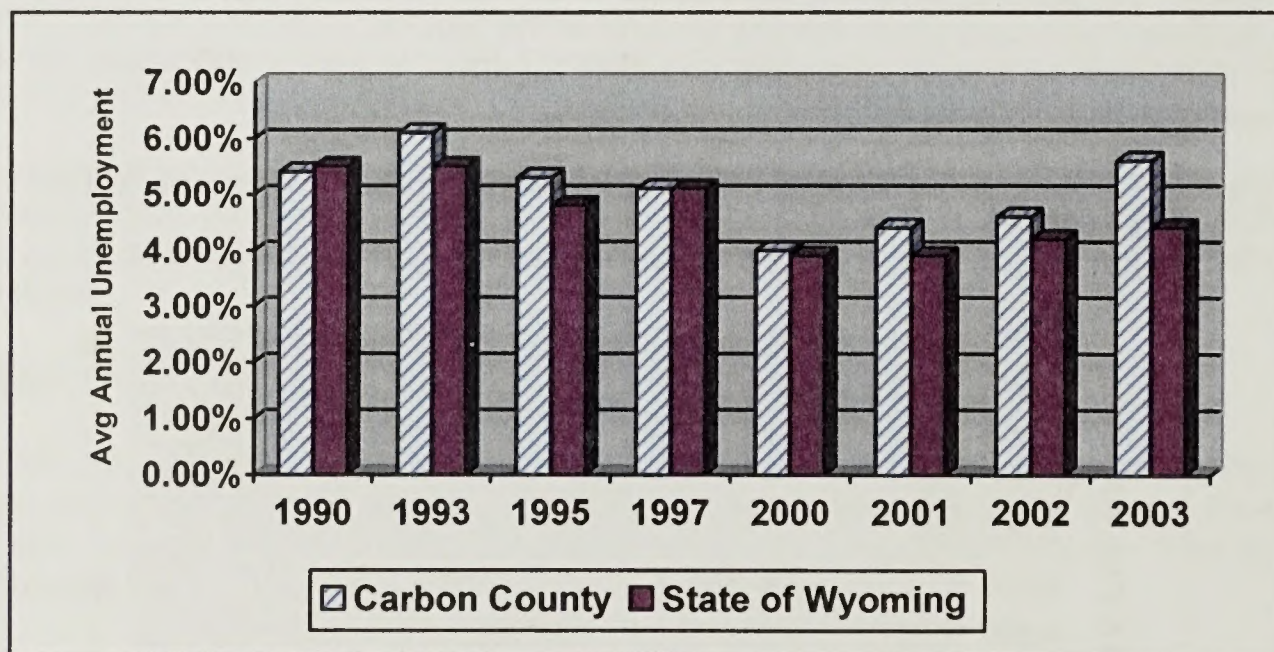
CHAPTER 3. AFFECTED ENVIRONMENT

mining sector losses over the past decade and the volatility in total employment are attributed to the shutdown of the Rosebud and Seminoe #2 mines (USDI-BLM 1999) and more recently the closure of the RAG Shoshone mine near Hanna (Rawlins Daily Times 2000). Although the number of direct mining jobs in Carbon County is relatively low, mining still generates a substantial number of indirect jobs in the construction, transportation, and service sectors, and additional induced jobs in all sectors of the economy.

Some economic sectors gained jobs between 1990 and 2000. Among the largest gainers were agricultural services and forestry, which increased from 106 to 260 jobs, a 145 percent increase; however, that sector fell to 143 jobs by 2002, a 45 percent loss in just 2 years, reflecting the closure of the Louisiana Pacific mill in Saratoga. Other gaining sectors were construction and services. Construction increased from 595 to 693 jobs between 1990 and 2000, a 16-percent gain, and then remained relatively stable between 2000 and 2002. Services increased by 16 percent from 1,848 to 2,141 jobs during the period.

Unemployment rates in Carbon County have varied considerably in recent years. Although slightly higher, unemployment generally tracks with the unemployment rate for the State of Wyoming as a whole. Between 1990 and 2002, the county's average annual unemployment rate ranged from a low of 4 percent in 2000 to a high of 6.1 percent in 1993 (figure 3-5). In 2003, the unemployment rate averaged 5.6 percent, or 451 unemployed persons in a total labor force of 8,121 (Blodgett 2003). This increase in unemployment was due in large part to the closure of the Louisiana Pacific mill. The size of the Carbon County labor force (people working or actively looking for work) decreased 9 percent between 1990 and 2003 (WDE 2004).

Figure 3-5. Average Annual Unemployment Rates: 1990–2003.



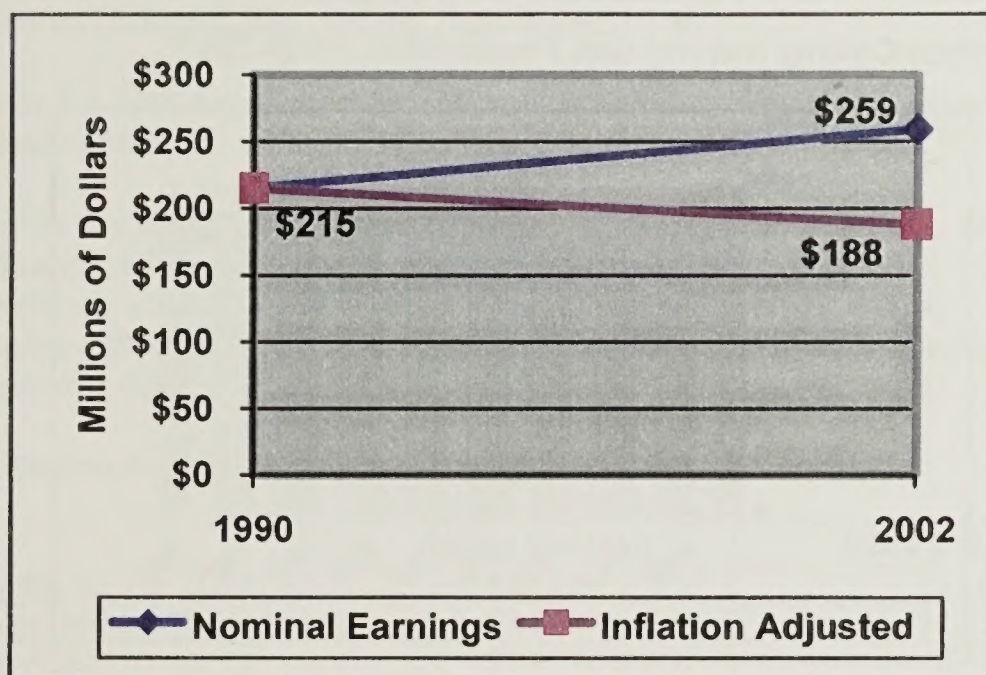
Source: WDE 2004

Although in the recent past there have been a substantial number of under-employed persons in Carbon County (PFResources 2000), there have been few experienced workers available for oil and gas drilling and completion jobs in recent years. Most drilling and completion companies bring crews with them and hire some entry-level workers locally and many gas field service companies bring workers from other states who relocate to Carbon or Sweetwater counties on a temporary, seasonal basis. However, there are qualified local contractors and employees available for gas field construction and service work (Blodgett 2003, 2004).

CHAPTER 3. AFFECTED ENVIRONMENT

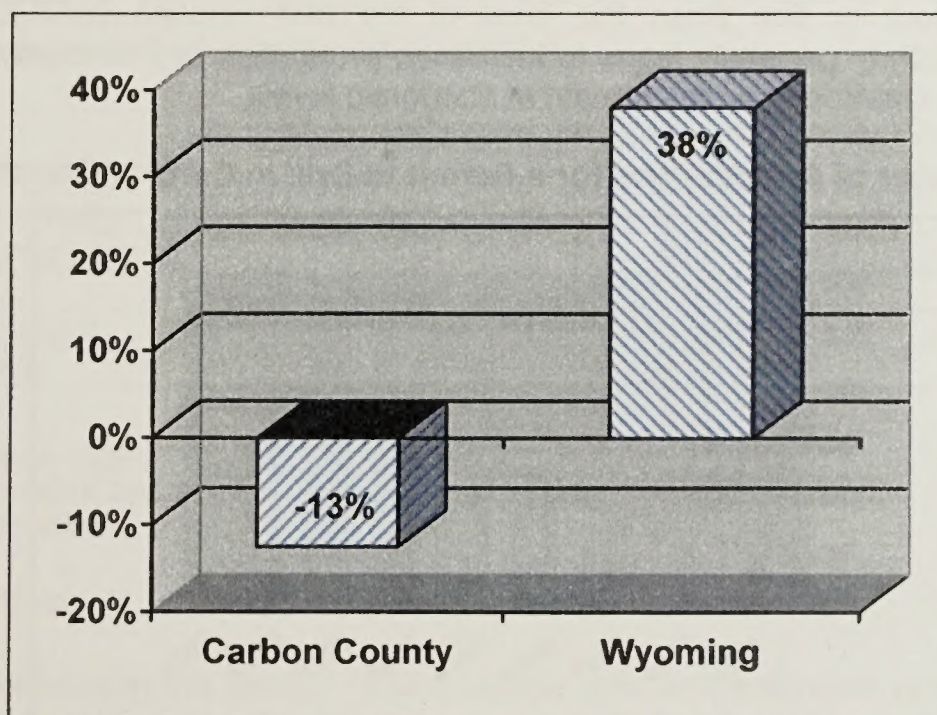
Between 1990 and 2002, total earnings associated with jobs located in Carbon County increased 20 percent, from \$215 million to \$259 million (figure 3-6). However, when adjusted for inflation, real Carbon County earnings decreased by 12.5 percent during the 12 years ending in 2002. For the same period, inflation-adjusted earnings increased 38 percent for the State of Wyoming as a whole (figure 3-7, WDAI 2003b). This general economic contraction reflects both a loss of jobs and a shift in jobs from higher paying mining jobs to generally lower paying agricultural and service jobs.

Figure 3-6. Total Carbon County Earnings by Place of Work: 1990–2002.



Source: WDAI 2003b

Figure 3-7. Change in Inflation-Adjusted Carbon County Earnings Contrasted with Wyoming & US: 1990–2002.



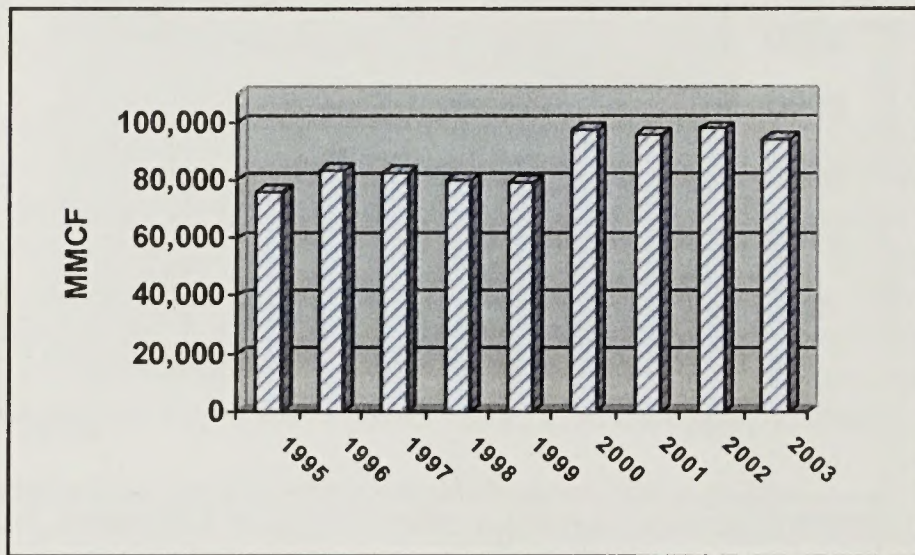
Source: WDAI 2003b

CHAPTER 3. AFFECTED ENVIRONMENT

3.12.1.1 Oil and Gas Activity

As shown on figure 3-8, Carbon County natural gas production increased from 75,851 million cubic feet (MMCF) in 1995 to 94,183 MMCF in 2003, an increase of 24 percent. Production in 2000 through 2002 was somewhat higher than in 2003. Carbon County oil production in 2003 was 1.6 million barrels or about 23 percent higher than the 1995 level of 1.3 million barrels. Production in 2002 was about 0.1 million barrels higher. During 2003, there were a total of 1,248 producing oil and gas wells in Carbon County, and the county produced 5.14 percent of total gas produced in Wyoming and 3.05 percent of total oil.

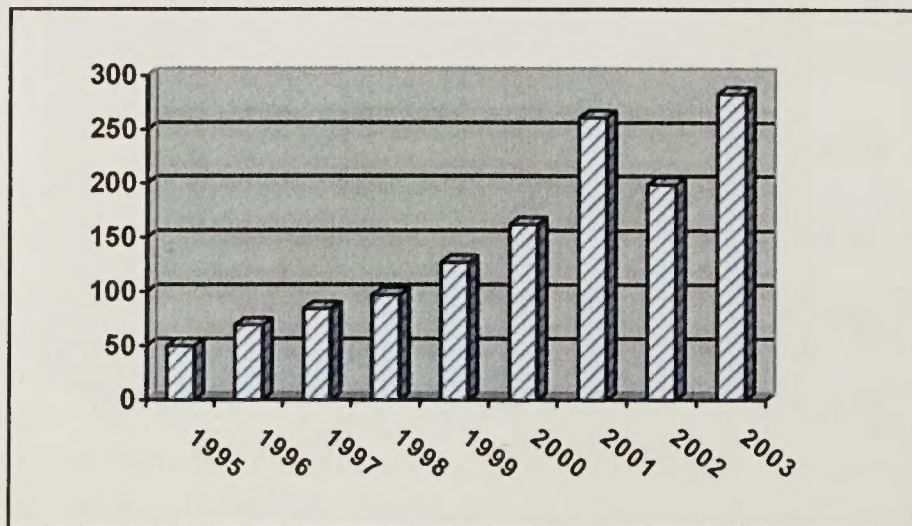
Figure 3-8. Carbon County Natural Gas Production: 1995–2003.



Source: WOGCC 1995–2003

The outlook for future oil gas production is in part reflected in the number of approved APDs that are logged each year. The number of approved APDs has increased substantially in Carbon County in recent years, from 50 in 1995 to 284 in 2003 and 199 in 2002 (figure 3-9), or levels of approved drilling four or five times the level of the mid nineties (WOGCC 1995–2003). Increased drilling activity generally leads to increased production in the county if drilling efforts are successful and commodity prices remain at economic levels.

Figure 3-9. Number of Applications for a Permit to Drill in Carbon County: 1995–2003.



Source: WOGCC 1995–2003

CHAPTER 3. AFFECTED ENVIRONMENT

3.12.1.2 Economic Activities in the Vicinity of the Proposed Action

Economic activities currently occurring on and near the ARPA include:

- Oil and gas exploration (Vosika 2000);
- Cattle grazing (Warren 2000); and
- Outdoor recreation including:
 - Hunting mule deer, antelope, elk, and upland birds;
 - OHVs and camping (usually related to hunting); and
 - Pleasure driving/wildlife viewing (See section 3.9).

Some lands within the ARPA are used by outfitters and some ranchers, who lease their lands to outfitters and allow hunting for a fee (Carrico 2005).

The BLM RFO is in the process of modifying the Great Divide RMP, which, when modified, will be called the Rawlins RMP. Appendix 35 of the Rawlins draft RMP EIS (USDI-BLM 2004c) contains assumptions about direct expenditures, total economic activity, employment and earnings associated with grazing, and recreation activities in the RFO Management Area for the modified management plan. Tables 3-41 and 3-42 present those estimates.

Table 3-41. Economic Estimates for Grazing.

	Cattle Grazing	Sheep Grazing
Direct Expenditures Per AUM	\$35.29	\$21.62
Total Economic Impact Per AUM	\$64.36	\$42.36
Earnings Per AUM	\$18.77	\$5.83
Jobs Per AUM	0.000709	0.0009513

Notes:

All monetary values in 2000\$

AUM - animal unit month

Source: Taylor 2004

Table 3-42. Economic Estimates for Recreation.

	Nonresident OHV/Day	Nonresident Hunting Day	Nonresident General Day
Direct Expenditures	\$119.13	\$116.31	\$40.55
Total Economic Impact	\$158.80	\$155.97	\$50.69
Total Employment	.003276	.005153	.001294
Total Earnings	\$49.30	\$50.80	\$14.58

Notes:

OHV - Off-highway vehicle

All monetary values in 2000\$

Source: Taylor 2004

3.12.2 Population

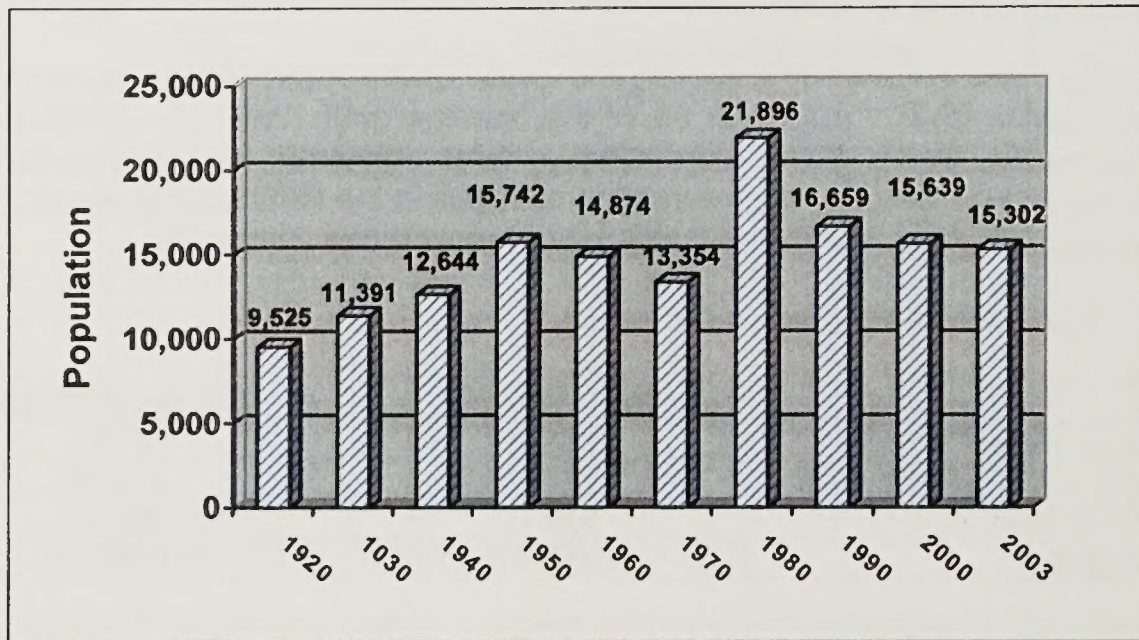
The population statistics in this section reflect census data and estimates prepared by the State of Wyoming. In all potentially affected communities, there has been a substantial transient workforce in recent years. Because these workers do not establish permanent residence in the

CHAPTER 3. AFFECTED ENVIRONMENT

communities and stay in temporary housing, they are not counted in population estimates. But in all affected communities, the total number of persons residing in the community at certain times of the year is substantially higher than is reflected in the following population statistics.

Carbon County's population growth and decline parallels the employment growth and decline cycle outlined at the beginning of this section. Figure 3-10 depicts the ups and downs of Carbon County's population since 1920. The population peaked in 1980 (mirroring the employment peak shown on figure 3-4) and has decreased 29 percent since then to 15,639 in 2000 (WDAI 2001). According to official state estimates for 2003, Carbon County population continued to decline losing another 337 people or about 2 percent since 2000 (WDAI 2002b).

Figure 3-10. Carbon County Population: 1920–2003.



Sources: WDAI 2001 & 2004a

Population in the city of Rawlins, the county seat and the largest community in Carbon County, mirrored the county trend between 1990 and 2000, although Rawlins has gained some population in the last 2 years as the county has continued to decline. Rawlins lost an estimated 842 persons between 1990 and 2000, ending the period at 8,538. Rawlins officials believe the city's population was undercounted in the 2000 census (Kilgore 2002). Between 2000 and 2003, Rawlins' population grew slightly to an estimated 8,665 according to state estimates (table 3-43).

Table 3-43. Population Estimates for Communities near the ARPA.

Community	1990	1995	2000	2003
Rawlins	9,380	9,063	8,538	8,665
Baggs	272	258	348	358
Dixon	70	67	79	80
Wamsutter	240	241	261	262

Sources: 2000 Census as reported in WDAI 2001, WDAI 2003d and 2004b

Other communities near the ARPA are small and have undergone small changes. The Town of Baggs, which, along with Dixon, is one of the closest communities to the ARPA, gained

CHAPTER 3. AFFECTED ENVIRONMENT

76 residents (28 percent) between 1990 and 2000, but only gained 10 persons between 2000 and 2003, ending the period at 358 persons. The Town of Dixon, several miles east of Baggs, has been relatively stable over the last 14 years, fluctuating between 65 and 80 residents.

In Sweetwater County, the Town of Wamsutter grew by an estimated 22 persons between 1990 and 2003 according to Wyoming Department of Administration and Information estimates. Wamsutter officials believe the number is substantially higher, both in resident population and in transient population (primarily oil and gas workers who stay in town for several weeks or months at a time) which may reach 200 or more at times (Carnes 2005).

3.12.3 Housing Resources

As of fall of 2005, available (vacant) housing was scarce in western Carbon County and eastern Sweetwater County. This housing inventory focuses on both long- and short-term housing resources available to accommodate growth due to gas development. Operations personnel and some field development personnel would require long-term housing, given the size and duration of the drilling and field development phase of the project. However, most CBNG drilling and field development activities are relatively short duration tasks performed primarily by contractors. Currently, drilling and completion activities occur less than 6 months out of each year resulting in a temporary, transient workforce and demand for temporary housing, such as motel rooms and spaces for mobile homes, recreational vehicles (RVs), and rig camps near the project area.

Recently, larger self-contained worker camps have been constructed or proposed in unincorporated portions of the county, including a camp along WY 789 north of Dad that currently houses about 80 workers and can be expanded to house a total of 150 workers (Adams 2005). This site is also permitted for another camp, but it is more likely that a second camp would be developed about 6 miles south of this area if demand arises. BP is also developing a 400-bed housing facility near Wamsutter.

Carbon County is in the process of reviewing rural subdivision regulations, which may make development of housing in unincorporated portions of the county easier. During the 2000 to 2004 period, residential building permits in Carbon County averaged about 38 per year.

3.12.3.1 Baggs/Dixon Area

In the Baggs/Dixon area, temporary housing resources include rental houses, duplexes, apartments, motels, and spaces in mobile home parks. During recent years, rental units have rarely been available; most have waiting lists (Herold 2005, Hicks 2005). A 26-space mobile home park in Baggs is equipped to accommodate RVs and mobile homes. Within the park there are several mobile homes for rent, but again, these are rarely vacant. There is a four-space mobile home park in Savery and a number of mobile home lots scattered throughout the Little Snake River Valley (Grieve 2000, 2002, 2003).

There are two motels in Baggs with a total of 64 rooms, most of which can accommodate more than one occupant. Both motels routinely accommodate oil and gas industry workers as well as tourists, travelers, and hunters (Willis 2000, Hawkins 2000). There is substantial turnover in these units, but demand exceeds availability during the drilling and hunting seasons.

CHAPTER 3. AFFECTED ENVIRONMENT

3.12.3.2 Wamsutter

Temporary housing resources in Wamsutter include three mobile home parks. One has 26 spaces (Englehart 2000, 2002), one has 70 spaces, and the third has 52 spaces (Waldner 2004). Most of these parks have units that are equipped to serve RVs (Waldner 2000, 2002). Some drilling and gas service contractors have put rig camps in these mobile home parks; a rig camp typically accommodates 10 to 12 workers (two shifts of 5 or 6 workers each). There are also two motels in Wamsutter (Carnes 2003).

There has recently been a limited amount of subdivision activity and housing construction in Wamsutter (Carnes 2005). A local developer/mobile home park owner is in the process of applying for a permit to develop additional RV spaces (Waldner 2005).

3.12.3.3 Rawlins

In Rawlins, temporary housing resources include 19 motels and 4 RV parks (Hiatt 2000) and, as of fall 2005, three new motels are being constructed with a total of 200 rooms. For longer-term housing, there are 18 mobile home parks with over 550 pads (City of Rawlins 1998), about half of which were vacant during the fall of 2005. The 2000 census listed 285 units in two to four-unit housing structures in Rawlins and 467 units in structures with over 5 units (US Census Bureau 2002); there are rarely vacancies in these housing types. Although Rawlins has some vacant single-family houses, most of the affordable units are substandard, and would require some rehabilitation to make them attractive to buyers (Kilgore 2005).

3.12.4 Community Facilities and Services

3.12.4.1 Carbon County

The Carbon County Sheriff's Department provides law enforcement services for Carbon County including the ARPA. The department has 14 full-time and 2 part-time sworn deputies including 7 who are stationed in Rawlins (Colson 2002). The department recently completed construction of a new jail.

Memorial Hospital of Carbon County would provide emergency response services in the ARPA. The hospital has 14 full- and part-time emergency medical technicians (EMTs) and three ambulances based at the hospital in Rawlins (Hightree 2002).

Carbon County also provides road construction and maintenance services on roads, which provide access to and within the ARPA (See section 3.13).

3.12.4.2 Rawlins

Most of the infrastructure of Rawlins was sized to accommodate a larger population than it currently has. The sewer system could accommodate a population of 25,000, more than twice the city's current population. With the completion of the new water supply pipeline in 2002, the water system also has excess capacity. In general, the Rawlins Community Development Director believes the community could accommodate 14,000 people with few changes to the current infrastructure (Kilgore 2002, 2004).

CHAPTER 3. AFFECTED ENVIRONMENT

3.12.4.3 Baggs Area

The Carbon County Sheriff's Department provides law enforcement services in the part of Carbon County near the ARPA. Currently, coverage is provided by two full-time and one part-time deputy. The deputies provide coverage for the town of Dixon and the community of Savery. There is one Wyoming Highway Patrol officer stationed in the area and the town of Baggs has two police officers (Colson 2000, Herold 2006).

Medical services in Baggs are provided at a county-owned clinic, staffed by a physician's assistant who is supported by other medical and administrative personnel. Emergency response is provided by six volunteer EMTs who staff two county-owned ambulances. Seriously injured patients are transported to Craig or Rawlins, depending on the location of the accident. Casper-based Flight-for-Life is also available if needed (Herold 2000).

Sewer and water services in the town of Baggs would require expansion to accommodate substantial population growth. The town is limited on water supply and the water treatment plant is currently at capacity. When the recently completed High Savery reservoir is full, the town will receive 300 acre feet per year, which would provide water supply for a population of 700. The town recently performed some improvements to its water system infiltration gallery, and is currently deciding on a design for a new treatment plant. The town's sewage treatment system has had some problems meeting discharge standards for ammonia, and may require some improvements to the aerated lagoon system. The town recently completed a utility master plan as a prelude to improving these systems. Other community facilities in Baggs are adequate for existing demand and can accommodate some population growth (Herold 2000 and 2006).

3.12.4.4 Wamsutter Area

Law enforcement in the Wamsutter area is currently provided by the Sweetwater County Sheriff's Department; a deputy patrols the town daily. Two Wyoming Highway Patrol officers also live in the town. The town of Wamsutter has positions for two part-time police officers, but the positions are currently vacant and the town has not been able to hire officers for the positions for some time (Schroeder 2005). Emergency response services are provided by 15 volunteer EMTs operating one ambulance and 10 volunteer firefighters operating two fire trucks.

The volunteer fire and ambulance services provide coverage to surrounding oil and gas operations, and both services may have difficulty responding to more than one emergency at the same time. BP America recently provided a \$68,000 grant toward purchase of a new ambulance; other energy and pipeline companies have also contributed funds. The town has an ongoing effort to recruit new volunteers for both the fire and ambulance service.

In general, sewer, water, and school facilities can serve a larger population than Wamsutter now has. The town is in the second phase of a program to improve the water distribution system. The town also is developing a new library and has identified a variety of street and infrastructure improvements, vehicles, and staff (Carnes 2002 and 2005, Williams 2001, and Rawlins Daily Times 2001). Although the transient drilling and field development population in Wamsutter can be substantial from time to time, their demands on local government facilities and services have generally been minor (Wyoming Business Council et al. 2002). Note that Wamsutter will host parts of two large pipeline construction workforces during late 2005 and 2006 (See section 5.12)

CHAPTER 3. AFFECTED ENVIRONMENT

and BP America is constructing a 400-bed worker camp on the outskirts of the town in late 2005.

3.12.4.5 Carbon County School District #1

Carbon County School District (CCSD) #1 serves Rawlins, Sinclair, Baroil, and the Little Snake River Valley including the communities of Baggs and Dixon. The district's facilities were built in the late 1970s when Carbon County had many more residents, so there is excess capacity in some schools in Rawlins and Baggs. Elementary schools in Rawlins are nearing capacity; a few students could be added to each class, but the addition of a substantial number of new students would require the use of modular classrooms. The Rawlins middle school could accommodate an additional 50 students and the Rawlins high school could absorb almost 1,000 students. The district plans to construct a new elementary school in Rawlins to replace the existing elementary schools and to remodel the existing middle school. Schools in Baggs could absorb additional students, particularly if they are distributed relatively evenly across all grades.

Funding operating costs for new students can be a burden because of Wyoming's school funding formula. The Wyoming School Foundation Program provides a guaranteed level of funding to every school district in the state. If a district's local property tax revenues do not equal the guaranteed level, the state makes up the difference. If the district's revenues exceed the guaranteed level, as is the case for CCSD #1, the excess is rebated to the state for use in other districts.

The Foundation Program formula computes school district operating budgets on a 3-year moving average. Therefore, if CCSD #1 has a substantial increase in enrollment in any one year, the district may not be allowed to fully increase its operating budget for the additional students for 3 years, unless the increase in enrollment equals or exceeds 10 percent of the district's previous year enrollment. If the district were to receive a substantial number of students in any 1 year, but less than a 10 percent increase over the previous year, the district would be required to hire new teachers and fund other operating increases without a corresponding increase in revenues (Blankenship 2002).

Property tax revenues accruing to CCSD #1 may exceed the recapture limit in the near future, however, which would allow the district to keep local revenue that exceeds the limit, although there are both time restrictions and spending restrictions associated with this revenue.

3.12.5 Local Government and State Government Revenues

Local and state government fiscal conditions that would be affected by development in the ARPA include *ad valorem* property tax revenues of Carbon County, CCSD#1, and certain special districts; sales and use tax revenues of the state, county, and municipalities; state severance taxes; and federal mineral royalty distributions.

3.12.5.1 Ad Valorem Property Tax

Carbon County assessed valuation in fiscal year (FY) 2002 was about \$515 million; this yielded total property tax revenues (to all taxing entities) of \$32.4 million. In FY 2003, total assessed valuation had fallen to \$382 million, which yielded total property tax revenues of \$24.6 million. Much of this decline in property tax valuation and revenue can be attributed to lower prices for natural gas. FY 2003 assessed valuation (from FY 2002 natural gas production) totaled about

CHAPTER 3. AFFECTED ENVIRONMENT

\$199 million, 44 percent lower than 2002 natural gas valuation. Total 2003 mill levies within the ARPA included 58.5 mills for the county, state, and local schools and the weed and pest district. Special district mill levies are also assessed and would add another 3 or 4 mills, depending on the tax district. Countywide, natural gas production accounted for about 66 percent of total assessed valuation in 2002 and about 52 percent in 2003 (WTA 2002 and 2003).

3.12.5.2 Sales and Use Tax

FY 2002 sales and use tax collections in Carbon County totaled about \$18.5 million including collections from a 4-percent statewide sales and use tax and a 1-percent general purpose local-option sales and use tax. Total FY 2003 collections fell to \$14.5 million, a 22-percent reduction (WDAI 2003b). In FY 2003, Carbon County added a specific-purpose local option sales and use tax of 1 percent to fund construction of a new jail and other capital facilities (WDOR 2003).

3.12.5.3 Severance Taxes

Wyoming assesses severance taxes against certain minerals produced in the state. These taxes include a 6-percent severance tax on natural gas. In FY 2002, severance tax distributions totaled \$299 million. In FY 2003, severance tax distributions climbed to \$429 million, a 43-percent increase over the previous year (WDAI 2003c). Much of the increase in severance tax revenues was attributable to natural gas price increases. Of the total, 43 percent was attributable to severance taxes on natural gas in 2002 and 54 percent was attributable to natural gas in 2003.

3.12.5.4 Federal and State Mineral Royalty Distributions

The federal government collects a 12.5-percent royalty on oil and natural gas extracted from federal lands. Fifty percent of those royalties are returned to the state where the production occurred. In Wyoming, the state's share is distributed to a variety of accounts including the University of Wyoming; the School Foundation fund; the Highway fund; the Legislative Royalty Impact Account; and to cities, towns, and counties. In FY 2002, a total of \$349 million in federal mineral royalty funds were distributed to Wyoming entities. In FY 2003, total mineral royalties increased to \$476 million, a 36-percent increase (WDAI 2003d).

The State of Wyoming collects royalties of either 16⅔ percent or 12½ percent on natural gas produced from state-owned lands. The revenues generated by trust lands and minerals are dedicated to common (public) schools and certain other designated public institutions, such as the Wyoming State Hospital.

3.12.6 Local Attitudes, Opinions, and Lifestyles

Ranchers who own property and have grazing permits within the ARPA will be among those directly affected by the proposed natural gas development. The LSRCD lists 13 landowners/grazing permit operators within the ARPA, nine who live in communities in the Little Snake River Valley (LSRV), three who live in Rawlins, and one who lives in Saratoga. Although there are some houses and mobile homes located in the ARPA, none are occupied full-time (Carrico 2005, Hicks 2004).

Currently, cattle grazing is the primary economic activity in the ARPA, although some horses are also raised. In earlier times, the area was primarily used for sheep grazing. The more labor-

CHAPTER 3. AFFECTED ENVIRONMENT

intensive requirements of sheep grazing, coupled with higher labor costs, resulted in a shift towards cattle, although some sheep are still raised in the grazing allotments that include portions of the ARPA (See section 3.6). Some of the ranches and grazing operations located in the ARPA have been in the same family for several generations. In addition to grazing, some ranchers lease their land to hunting outfitters, or allow hunting access for a fee. Some ranches and grazing allotments have installed range improvements including water features that benefit and attract wildlife and cattle.

Ranching has been the primary economic activity in the LSRV since the establishment of European settlements in the area and has been the dominate use of the land. Ranching-related activities, such as rodeos and roping competitions, are among the important and long-enduring social interactions in the valley (Hicks 2003).

Resource extraction—primarily oil and more recently natural gas—has been an important component of the economy of the LSRV. Some oil and gas service companies are located in the valley, and natural gas development employees frequently use motels, mobile home parks, and campgrounds in the LSRV while working in nearby oil and gas fields (Blevins et al. 2003, Herold 2006). A recent social assessment conducted for the Medicine Bow National Forest Plan update identified grazing permits, water rights, and to a lesser degree access to public lands as important issues for LSRV residents (Blevins et al. 2003).

A 1996 survey conducted in conjunction with the preparation of the Carbon County Land Use Plan investigated resident attitudes and opinions regarding land use, oil and gas development, natural resource conservation and use, and other topics. Just over 300 residents completed the survey (Carbon County Board of Commissioners and Carbon County Planning Commission 1998). The most frequently listed land use issues of importance were water resource conservation and concern for government regulation of land use. These issues were followed closely by availability of water to support future land uses, economic viability of ranching, timber and oil and gas industries, and the need to conserve wildlife habitat.

County-wide, 54.9 percent of survey respondents (based on a weighted average because some respondents gave more than one response) indicated that conservation of land, water, and wildlife resources was more important than increased oil and gas production, while 36.9 percent indicated that increased oil and gas production was more important. Among Baggs residents, the reverse was true. About 54 percent rated increased oil and gas production as more important than conservation of land, water, and wildlife resources, while 36 percent rated resource conservation as more important. The land use plan attributes this difference in attitude to Baggs' greater economic dependence on future oil and gas employment.

Concerning management of federal lands, the largest number of respondents (69.5 percent) indicated that more federal lands within the county should be designated for the purpose of conserving fish and wildlife habitat and surface and groundwater resources. In addition, 60.8 percent of respondents indicated that more land should be designated for public recreation, 48.8 percent indicated more land should be leased for oil and gas industry exploration and production, 48.7 percent indicated more land should be leased for commercial mining, and 44.5 percent indicated more land should be made available to local timber companies for commercial timber harvest.

CBNG development was not considered by the survey, so resident attitudes and opinions specific to CBNG are unknown (Hewitt 2001).

CHAPTER 3. AFFECTED ENVIRONMENT

3.12.7 Environmental Justice

EO 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations," was published in the Federal Register (59 FR 7629) on February 11, 1994. EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (defined as those living below the poverty level).

Table 3-44 presents the percentage of minorities in areas near the ARPA. Minorities are 10.3 percent of the population in the analysis area that includes the ARPA and populations within five miles of the ARPA boundary. This is 0.8 percentage points lower than the state average of 11.1 percent. The percentage of minorities in Carbon County overall is higher than the state average because of the presence of the Wyoming State Penitentiary. Near the southern boundary of the ARPA, Baggs and Dixon have relatively low minority percentages of 7.5 percent and 5.1 percent, respectively. The Hispanic or Latino population is the largest minority group.

Table 3-44. Percentage of Minorities in Selected Communities.

	Minority Persons in 2000 as % of Total Population	Percentage Points Above/ Below the State Average
Wyoming	11.1	
Carbon County	17.6	6.4
ARPA and Areas Nearby ¹	10.3	-0.8
Baggs	7.5	-3.7
Dixon	5.1	-6.1

Notes:

¹ Defined as Block Group 2 of Carbon County Census Tract 9676, excluding blocks generally east of the Atlantic Rim, the Bridger Pass Road, and the Little Savery Creek and Savery Creek drainages. Baggs, Dixon, and areas near Rawlins that are south of I-80 and west of Highway 71 are included in the analysis area.

Source: U.S. Census Bureau, Census 2000, Summary File 1 (U.S. Census Bureau 2000a).

Table 3-45 presents the percentage of persons in poverty in ARPA and surrounding communities. For this analysis, the local area that includes the ARPA is larger than the analysis of minorities because of the data available from the U.S. Census Bureau.

Table 3-45. Percentage of Persons in Poverty in Selected Communities.

	Persons in Poverty in 1999 as % of Total Population	Percentage Points Above/ Below the State Average
Wyoming	11.4	
Carbon County	12.9	1.5
ARPA and Communities Nearby ¹	14.1	2.7
Baggs	14.9	3.5
Dixon	8.0	-3.4
Rawlins	13.7	2.3
Sinclair	4.7	-6.8

Notes:

¹ Defined as Block Group 2 of Carbon County Census Tract 9676, which includes Baggs, Dixon, areas near Rawlins and Sinclair south of I-80, and other parts of Carbon County south of I-80 and west of the North Platte River.

Source: U.S. Census Bureau, Census 2000, Summary File 3 (U.S. Census Bureau 2000b).

CHAPTER 3. AFFECTED ENVIRONMENT

Persons in poverty are 14.1 percent of the population in the analysis area that includes the ARPA. This is higher than the overall rates for Carbon County and the State of Wyoming. However, the high poverty rate is mainly due to having to include the Wyoming State Penitentiary in the analysis area, which also includes Baggs, Dixon, and other parts of Carbon County south of I-80 and west of the North Platte River.

3.13 Transportation

The regional transportation system serving the project area includes an established system of interstate and state highways and county roads. County roads and improved and unimproved BLM and private roads serve local traffic on federal land. Access to the ARPA is provided by a combination of interstate and state highways and Carbon County and BLM roads (map M-33).

3.13.1 Highway Access to the Project Site

The Wyoming Department of Transportation (WYDOT) measures annual average daily traffic (AADT) and collects accident statistics on federal and state highways. Table 3-46 displays these data for the highways that provide access to the ARPA. WYDOT also assigns levels of service to highways in the state system. Levels of service (LOS A through LOS F) are assigned based on qualitative measures (speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience) that characterize the operational conditions within traffic streams and the perceptions of those conditions by motorists. LOS A represents the best, or free flowing, travel conditions and LOS F represents the worst, or total stoppage of traffic flows. The LOS ratings for the highways accessing the ARPA, where designated, are also shown in table 3-46.

Table 3-46. Highway Access Routes to the ARPA.

Highway	1991 AADT	2001 AADT	2002 AADT	Projected 2012 AADT	Level of Service	Average Accidents 1996–2000
I-80 (Junction WY 789)	7,590 (3,580 trucks)	12,000 (6,260 trucks)	11,760 (6,460 trucks)	15,000	A	123.4
WY 789 (Creston Jct. - Baggs)	720 (240 trucks)	890 (210 trucks)	860 (210 trucks)	800	B	18.8
WY 70 (Dixon west)	530 (65 trucks)	490 (40 trucks)	480 (30 trucks)	550		14.8
WY 71 (I-80 south)	200 (30 trucks)	150 (30 trucks)	180 (20 trucks)	160		3.2

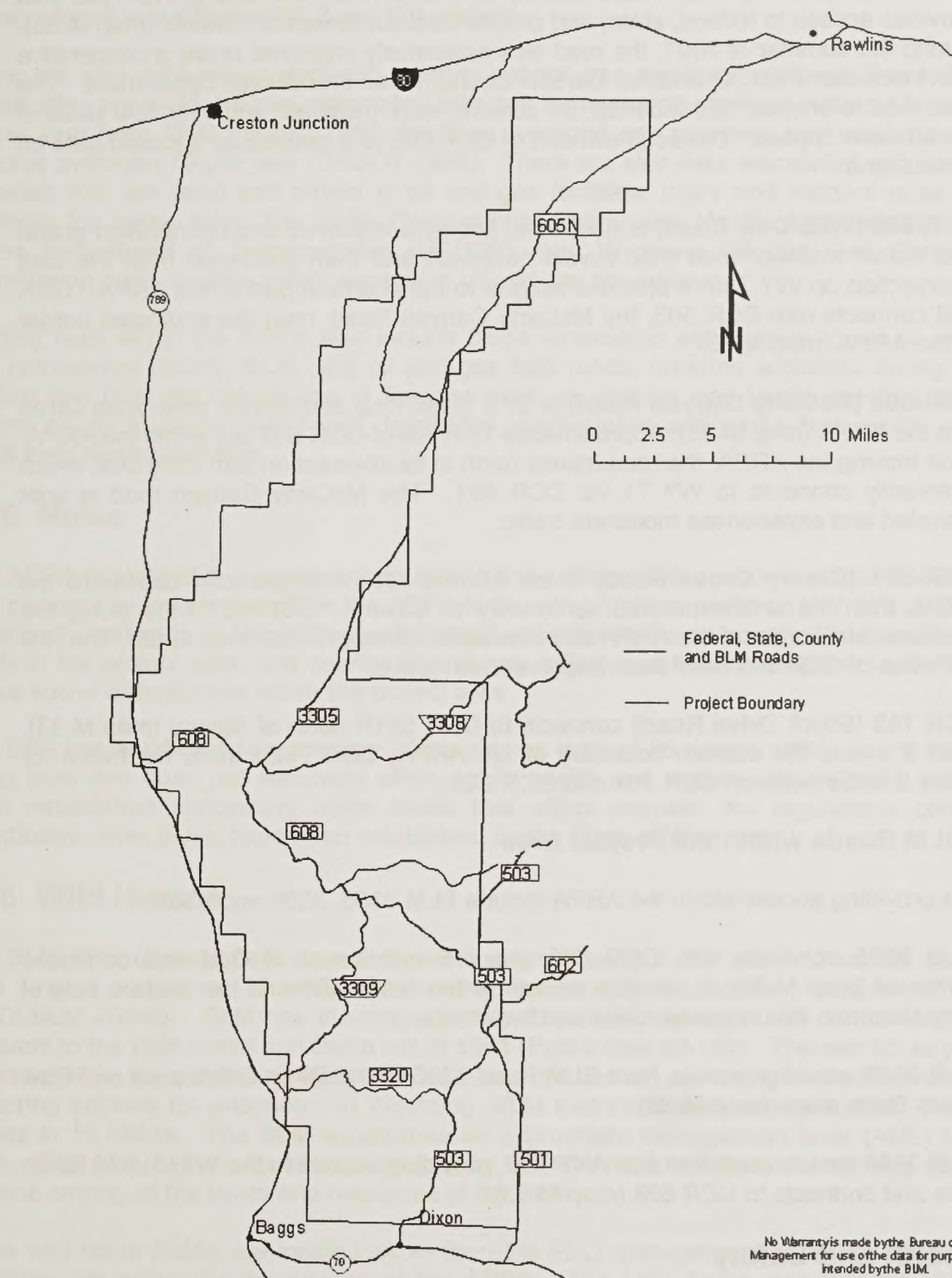
Source: WYDOT 2000, 2001, 2002

3.13.2 County Road Access to and within the Project Area

A number of Carbon County roads provide access to and within the ARPA. The traditional use of these county roads is to access federal, state, and private lands for livestock management, recreation, and more recently oil and gas exploration and production purposes. The county has improved several county roads including CCR 608 (Wild Cow Road) and CCR 605N (Twenty Mile Road North), to better serve oil and gas development and production. Except for these two roads, county roads within the project area are minimally maintained and are not plowed during winter (Evans 2002).

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-33. Federal, State, County, and BLM Roads.



CHAPTER 3. AFFECTED ENVIRONMENT

The following provides a more-detailed description of county roads providing access to and within the ARPA:

- **CCR 605N (Twenty Mile Road North)** is a 24.3-mile, two-lane gravel road that provides access to federal, state, and private land southwest of Rawlins (map M-33). During the summer of 2001, the road was extensively improved under a cooperative effort between PEDCO and the Carbon County Road and Bridge Department. The road was re-shaped and widened, 21 culverts were installed, and over 800 loads of gravel were applied. The southern end of CCR 605 N is defined by a locked gate on private land.
- **CCR 608 (Wild Cow Road)** is a 22-mile, two-lane improved and unimproved gravel and native material road that travels northeast and then southeast from the Dad intersection on WY 789. It provides access to the southern part of the ARPA. CCR 608 connects with CCR 503, the McCarty Canyon Road, near the southeast border of the ARPA (map M-33).
- **CCR 503 (McCarty Canyon Road)** is 37.2 miles long and travels north from Dixon into the ARPA (map M-33). Approximately 13 miles of CCR 503 are within the ARPA. After leaving the ARPA, the road travels north to its intersection with CCR 505, which eventually connects to WY 71 via CCR 401. The McCarty Canyon road is spot graveled and experiences moderate traffic.
- **CCR 501 (Cherry Grove Road)** is an 8.6-mile road that provides access to the ARPA from the unincorporated community of Savery. CCR 501 runs along the southeastern border of the ARPA and intersects with CCR 752 (map M-33). The first 4.3 miles of CCR 501 have been improved with gravel.
- **CCR 752 (Stock Drive Road)** connects to CCR 561N north of Savery (map M-33). After it enters the eastern boundary of the ARPA, CCR 752 travels northwest for about 2 miles between CCR 501 and CCR 503.

3.13.3 BLM Roads within the Project Area

BLM roads providing access within the ARPA include BLM 3305, 3308 and 3309:

- **BLM 3305** connects with CCR 608 about 5 miles east of Dad and continues northeast (map M-33). It provides access to the Sand Hills and the eastern side of Doty Mountain via unnamed roads and two-tracks.
- **BLM 3308** provides access from BLM Road 3305 to the Deep Gulch area and Cow Creek Butte areas (map M-33).
- **BLM 3309** travels northeast from WY 789, providing access to the Wild Horse Basin area and connects to CCR 608 (map M-33).

3.14 Health and Safety

Existing health and safety concerns in and near the ARPA include hazards associated with oil and gas exploration and operations. Workers generally are exposed to the occupational hazards

CHAPTER 3. AFFECTED ENVIRONMENT

of oil and gas operations in the fields and at ancillary facilities. Two types of workers are employed in oil and gas fields: oil and gas workers, who had an annual accident rate of 4.0 per 100 workers in 1998, and special trades contractors, who had a non-fatal accident rate of 8.9 per 100 workers (USDOL-BLS 2000). These rates compare with an overall private-industry average for all occupations of 6.2 per 100 workers.

There are also risks associated with existing natural gas pipelines, although these risks are statistically very small. Injuries associated with gas transmission pipelines nationwide averaged 14 per year from 1990 through 1996, fatalities averaged one per year, and incidents such as ruptures averaged 79 per year (USDOT 1998). There are also risks associated with hazardous materials that are used and stored at oil and gas facilities; injury and incident rates are not available for these risks. The BLM, Occupational Safety and Health Administration, United States Department of Transportation (USDOT), and Wyoming Oil and Gas Conservation Commission each regulate safety aspects of oil and gas operations.

Existing risks within the ARPA also include those associated with vehicle travel on improved and unimproved county, BLM, and oil and gas field roads; firearms accidents during hunting season and from the casual use of firearms such as plinking and target shooting; and with natural events such as flash floods, landslides, earthquakes and range fires, which can also result from human activities.

3.15 Noise

The ARPA is located in a sparsely populated rural setting having modest sound disturbances. The principal sound source within the ARPA is the wind. Vehicle traffic on WY 789 and WY 70; jet aircraft overflights at high altitudes; localized vehicular traffic on county, BLM, and two-track roads in the project area; and nearby oil and gas drilling and field development activities also cause sound disturbances within the project area.

The EPA has established an average 24-hour noise level of 55 decibel (dBA) as the maximum noise level that does not adversely affect public health and welfare. No definitive data have been established concerning noise levels that affect animals. No regulations concerning quantitative noise levels have been established by the State of Wyoming.

3.16 Wild Horses

The BLM RFO management area is home to approximately 1,400 wild horses, the second or third largest population of wild, free-roaming horses (*Equus caballus*) outside of Nevada (USDI-BLM 2003c). BLM has the responsibility to protect, manage, and control wild horses pursuant to the Wild Horse and Burro Act of 1971 (Public Law 92-195). The wild horse program is responsible for monitoring both the land and the herds, removing excess animals, and preparing animals for adoption. In Wyoming, BLM maintains and manages about 3,100 wild horses in 16 HMAs. The BLM establishes an appropriate management level (AML) for each HMA. The AML is the population objective for the HMA that will ensure a thriving ecological balance among all the users and resources of the HMA.

Three wild horse HMAs are located within the BLM RFO management area; however, none of the three are within the boundaries of the ARPA. The Lost Creek and Stewart HMAs are generally located northwest of Rawlins with the larger Adobe Town HMA primarily located in southern Sweetwater County. The Stewart Creek HMA is generally located northwest of

CHAPTER 3. AFFECTED ENVIRONMENT

Rawlins, with its southeast boundary beginning near the intersection of U.S. Hwy. 287 and CCR 63 (about 14 miles northwest of Rawlins). The Lost Creek HMA lies within the Great Divide Basin to the west of the Stewart Creek HMA. A fenced border separates the two HMAs.

The nearest of the three HMAs to the ARPA is the Adobe Town HMA. The eastern border of the Adobe Town HMA extends to within 5 miles of the western boundary of the ARPA west of WY 789. Daily or seasonal movement of wild horses from the Adobe Town HMA to the ARPA is effectively prevented by the state-maintained, limited access fencing along WY 789. The presence of wild horses in the project area is highly unlikely and is not considered to be an issue.

3.17 Special Management Areas

SMAs are designated to protect or preserve certain qualities or uses in areas that best provide them. The environment in these areas is unique in some regard, so that it is desirable to apply different management to the areas than is applied to the surrounding public lands. This section identifies the various SMAs (map M-34) within the ARPA and addresses the qualities or uses that have resulted in their designation. The types of special management designation within the ARPA include ACECs, cultural resource management areas, cooperative fish and wildlife management areas, and other unique geographical areas.

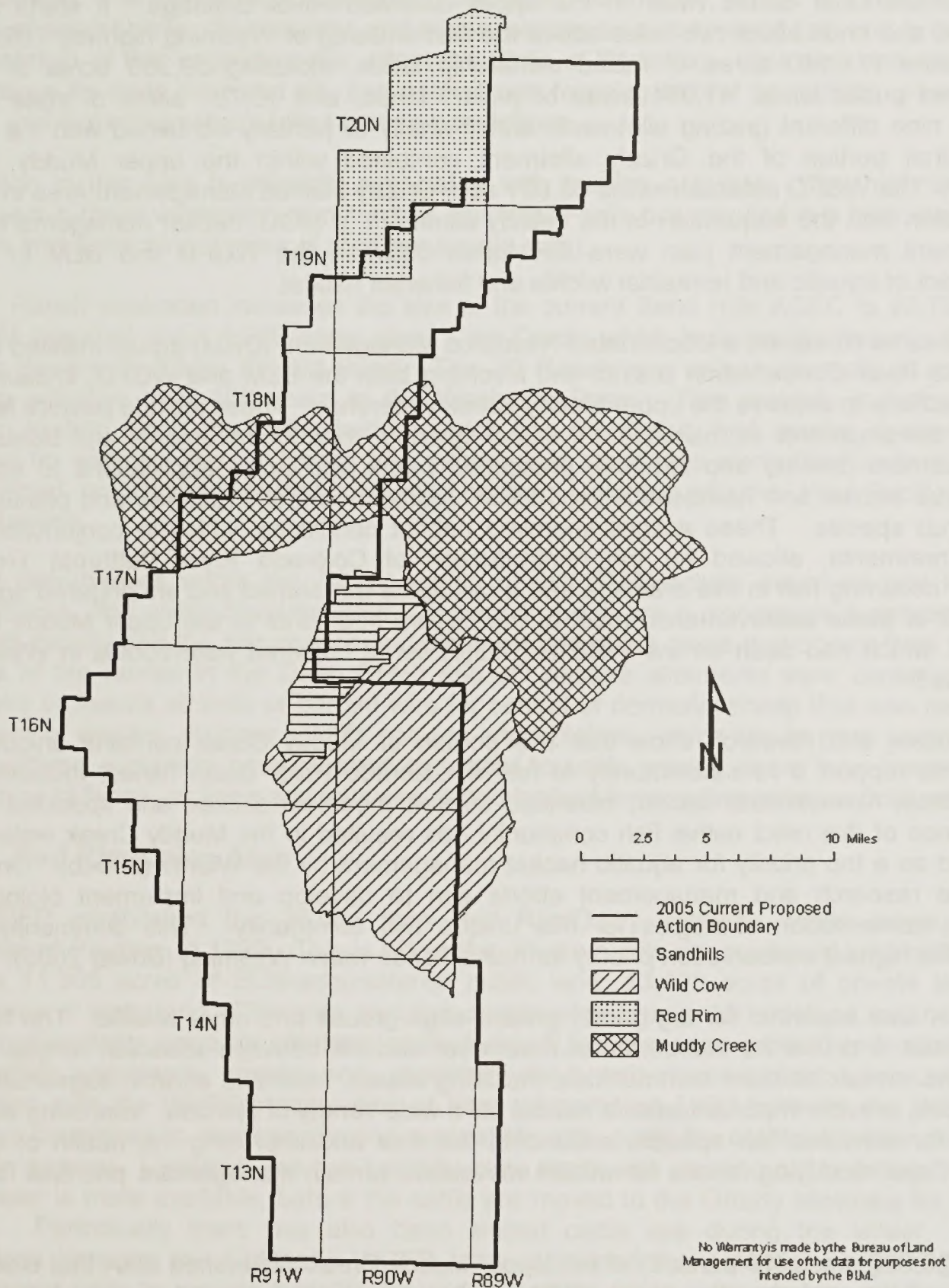
3.17.1 Cow Butte/Wild Cow Area

The Cow Butte/Wild Cow SMA, located between Rawlins and Baggs, was developed to promote management of upland and riparian habitats for wildlife and other multiple-uses. It encompasses 63,697 acres of mostly BLM-administered public land (50,232), along with 4,768 acres of private land and 8,697 acres of state land. The Cow Butte/Wild Cow SMA borders the Upper Muddy Creek Watershed SMA to the north and the Sandhills ACEC to the northwest. This area includes portions of the Cow Creek, Deep Gulch, Wild Cow and Cherokee Creek drainages.

There are seven different grazing allotments either wholly or partially contained within the SMA, including that portion of the Grizzly allotment which lies outside the upper Muddy Creek watershed. The WGFD established the 38,091 acre Grizzly Habitat Management Area in 1992. In conjunction with the acquisition of the Grizzly allotment, an Memorandum of Understanding (MOU), habitat management plan, and allotment management plan were developed between the WGFD and BLM to guide management of aquatic and terrestrial wildlife and fisheries habitat. Prior to and during this same timespan, the BLM, permittees, and the Little Snake River Conservation District have worked on adjoining allotments to implement a variety of actions to improve watershed and vegetation condition. These include pasture fencing and water developments to manipulate livestock grazing, road improvements to reduce sediment delivery into streams, and prescribed burns to improve upland shrub habitat and herbaceous production. Four larger reservoirs have been constructed recently by the LSRCD, including funding from the Wyoming Water Development Commission, to support sport fisheries, create aquatic habitat, and provide water for livestock. These actions have all helped to improve riparian and upland habitat conditions, however, upland plant community health and modification of fences for wildlife benefit remain management priorities for this area. Approximately 40,414 acres (63 percent) of the Cow Butte/Wild Cow SMA lies within the south-central portion of the ARPA.

CHAPTER 3. AFFECTED ENVIRONMENT

Map M-34. Special Management Areas Overview.



CHAPTER 3. AFFECTED ENVIRONMENT

3.17.2 Upper Muddy Creek Watershed/Grizzly Area

The Upper Muddy Creek Watershed SMA, located between Rawlins and Baggs, was developed to promote management of aquatic fish species and their habitat in upper Muddy Creek, a tributary to the Little Snake River in the upper Colorado River drainage. It starts at the headwaters and ends about two miles above the first crossing of Wyoming highway 789. This area contains 111,110 acres of mixed ownership lands, including 59,285 acres of BLM-administered public lands, 41,034 acres of private lands, and 10,791 acres of state lands. There are nine different grazing allotments either wholly or partially contained within the SMA, including that portion of the Grizzly allotment contained within the upper Muddy Creek watershed. The WGFD established the 38,091 acre Grizzly Habitat Management Area in 1992. In conjunction with the acquisition of the Grizzly allotment, a MOU, habitat management plan, and allotment management plan were developed between the WGFD and BLM to guide management of aquatic and terrestrial wildlife and fisheries habitat.

During this same timespan, a Coordinated Resource Management (CRM) group, initiated by the Little Snake River Conservation District and involving both the BLM and WGFD, implement a variety of actions to improve the upper Muddy Creek watershed. These include pasture fencing and water developments to manipulate livestock grazing, road improvements and closures to reduce sediment delivery into streams, prescribed burns and Spike applications to improve upland shrub habitat and herbaceous production, gradient control structures and plantings of woody shrub species. These actions improved habitat conditions, which in conjunction with fisheries treatments, allowed for the reintroduction of Colorado River Cutthroat Trout, a historically occurring fish in this drainage and a candidate threatened and endangered species. As a result of these achievements, most of the stream segments in the upper Muddy Creek watershed, which had been on the WDEQs' 303(d) list of impaired waterbodies in Wyoming, were delisted.

Recent studies and research show that this portion of Muddy Creek contains unique fish habitats that support a rare community of native Colorado River Basin fishes, including the roundtail chub, flannelmouth sucker, bluehead sucker, mountain sucker, and speckled dace. The presence of this relict native fish community has resulted in the Muddy Creek watershed being listed as a top priority for aquatic habitat management by the WGFD (2004b). Ongoing cooperative research and management efforts aim to develop and implement biologically meaningful conservation strategies for this unique fish community. This community may represent the highest conservation priority for native fishes within Wyoming (Bower 2005).

This area is also important for big game, greater-sage-grouse and other wildlife. The Muddy Creek corridor is critical for movement of mule deer and elk between seasonal ranges. The diversity and mosaic of plant communities, including aspen, mountain shrubs, sagebrush and riparian types, provide important wildlife habitat for a wide variety of species. Improving aquatic conditions for sensitive fish species, expanding the size and improving the health of aspen woodlands, and modifying fences for wildlife movement remain management priorities for this area.

There are 20,996 acres (19 percent) of the Upper Muddy Creek Watershed SMA that cuts east to west across the central portion of the ARPA.

CHAPTER 3. AFFECTED ENVIRONMENT

3.17.3 Sand Hills ACEC and Proposed JO Ranch Expansion

The Sand Hills ACEC and the JO Ranch Expansion protects about 5,024 acres of public land within the ARPA for its unique vegetation complex, wildlife habitat values, and recreational opportunities. The silver sagebrush/bitterbrush plant community, which is interspersed with patches of serviceberry, chokecherry, and aspen, occurs on a deep sand soil, and is the largest representation of this vegetative mix within the State of Wyoming. This area provides crucial winter range for mule deer and elk, and nesting and foraging habitat for raptors, greater sage-grouse, and Columbian sharp-tailed grouse populations.

Recreation in this area is primarily associated with hunting activities. The high amount of vehicle use in these vegetation communities and fragile soils has resulted in a high road density (in some areas reaching 9 miles of road per square mile).

The JO Ranch expansion increases the size of the current Sand Hills ACEC to 12,700 acres. The BLM acquired about 1,200 acres along Cow Creek, which includes the historic JO Ranch and the Rawlins to Baggs Freight Road. The JO Ranch is a unique example of continuous ranching activities over 100 years in the Washakie Basin. This property includes a flood irrigation system along the valley bottom which has resulted in high quality riparian habitat important for wildlife. The JO Ranch also served as a stage stop along the Rawlins to Baggs Freight Road, an historic route that connected northern Colorado with the Union Pacific Railroad line in Rawlins.

Existing disturbances within the ARPA portion of this SMA include improved and two-track roads, fences, and water developments. Two-track roads are a management concern due to their high density and the disturbance and displacement of big game that occurs from vehicles. Portions of the fences in the Deep Gulch and JO pasture allotments were constructed with mesh wire or five/six strands of barbed wire for control of domestic sheep that also restrict the movement of smaller, younger wildlife species and antelope, which like to pass under fences. Because these allotments have all been converted to cattle grazing, there is no longer a need for this type of fence, as three and four wire strand barbed fence adequately controls cattle.

3.17.4 Red Rim/Daley Area

The WGFD established the 26,083 acre Red Rim/Daley antelope winter range, located southwest of Rawlins, in 1992. This is within the private/public checkerboard land pattern, and includes 11,305 acres of BLM-administered public land, 13,498 acres of private land, and 1,280 acres of state land. The area contains crucial winter range for antelope and mule deer, and winter/yearlong range for antelope, mule deer, elk, greater sage-grouse, and other wildlife, which utilize sagebrush, greasewood, mountain shrub and riparian plant communities. In conjunction with the WGFD's acquisition of base property, an MOU between the WGFD and BLM was developed to manage grazing compatible with goals for antelope winter range and habitat in general. Livestock use has typically been made with yearling cattle during the spring when water is more available, before the cattle are moved to the Grizzly allotment for summer grazing. Periodically there has also been limited cattle use during the winter. Recent discussions between the BLM and WGFD have expanded the potential for grazing habitat management units to provide benefits for wildlife outside these units, as long as the purpose and intent of the unit is still being met.

CHAPTER 3. AFFECTED ENVIRONMENT

During the winter of 2003-04, over 300 elk died on the management unit due to lichen poisoning. Monitoring of lichen and other vegetation, development of reliable water sources, and improving the diversity and productivity of upland and riparian habitats are the management priorities for this area. The portion of the Red Rim/Daley area overlapping into the ARPA is relatively small at 3,190 acres (12.3 percent). Located in the southeast corner of the management area, the public land portion in the ARPA only amounts to two percent of the management area.

Chapter 4

Analysis of Environmental Consequences

4 Analysis of Environmental Consequences

The purpose of this chapter is to analyze and disclose the environmental effects for the Atlantic Rim project including the potential for significant impacts of the *federal action* on the *human environment*. The Council on Environmental Quality regulations for implementing NEPA states that the human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment [40 CFR §1508.14]. The *federal action* in this case is the Proposed Action and the alternatives, which the BLM is reviewing and disclosing impacts in anticipation of issuing a ROD on this project.

Analysis of the alternatives focuses on identifying types of impacts and estimating their potential significance. Throughout this chapter the terms *impact* and *effect* are synonymous. While impacts may be perceived as positive (beneficial) or negative (adverse), those determinations are left for the reader of this document to decide.

Each resource area in this chapter is organized as follows, along with the content of each subsection:

- **Introduction.** In here, the type and range of potential impacts that could occur as a result of the project are described.
- **Impact Significance Criteria.** Significance criteria are developed to gauge the magnitude of an impact on the human environment. Applicable management objectives from the Great Divide RMP are transposed in these subsections as significance criteria. The BLM also took into consideration consistency with the significance criteria found in the Rawlins RMP Draft EIS. Where an anticipated effect is determined to exceed the Atlantic Rim significance criteria, significant impacts (significantly as described in 40 CFR 1508.27) are determined to exist.
- **Direct and Indirect Impacts.** This subsection indicates which impacts are significant relative to the impact significance criteria. It illustrates the impact assessment of the proposed action and alternatives. The following defines direct and indirect impacts:
 - Direct Impacts are effects that are caused by the action and occur at the same time and place. Examples include the elimination of original land use due to the erection of a structure. Direct impacts may cause indirect impacts, such as ground disturbance resulting in resuspension of dust.
 - Indirect Impacts are effects that are indirectly caused by the action. They occur later or are farther removed in distance, but are still reasonably foreseeable and related to the action by a chain of cause and effect. Indirect impacts may reach beyond the natural and physical environment (e.g., environmental impact) to include growth-inducing effects and other effects related to induced changes to resource users (e.g., non-environmental impact).
- **Impacts Summary.** These subsections include a narrative comparison of direct and indirect impacts that would occur under each alternative and between alternatives.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

- **Additional Mitigation Measures.** Under these subsections, resource specialists identify additional mitigation measures that could be applied to avoid or reduce impacts above and beyond those listed in the appendices and applicant committed measures. The mitigation measures are in addition to any measures defined in the alternatives.

After assessing direct and indirect impacts in this chapter, cumulative impacts are analyzed in chapter 5. Cumulative impacts from the Proposed Action and the alternatives are analyzed in the context of other ongoing and recently approved activities, recently constructed projects and other past projects, and projects likely to be implemented in the near future reasonably foreseeable future activities (RFFAs) within the vicinity of the ARPA.

4.1 Geology, Mineral, and Paleontology Resources

4.1.1 Introduction

4.1.1.1 Geology

Of the geological features described in section 3.1, the surface environment could be impacted by the Proposed Action and alternatives, which would subsequently affect the geology of the ARPA and cause the geological hazard, mass movement. Removing vegetation or soils, could lead to flooding as a result of decreased infiltration rates and increase overland flow rate. If unmitigated, accelerated erosion that could result may cause gulying in some areas and rapid deposition or siltation in other areas with associated erosion effects. Mass movements, including landslides could be triggered in areas that become oversteepened by erosional removal of slope-supporting material. Altering existing topography, particularly by steepening slopes, could also trigger mass movements and accelerated erosion.

The Proposed Action or its alternatives would not contribute to increased risks of earthquakes. Earthquakes could result in damage to above-ground structures although the likelihood of earthquakes is low as indicated by the absence of recorded epicenters in the ARPA. Buried structures would only be affected if shaking induces ground failure or subsurface rupture. Pyrophoricity and subsidence effects to the geologic (surface) environment have been discussed in chapter 3 and are not considered a concern.

The magnitude of impacts to the geology and geological hazards associated would be reduced by the implementation of mitigation measures for geology, soils, vegetation, and water described in appendix H and adherence to the Great Divide RMP. In addition, no additional mitigation measures would be needed for geology.

4.1.1.2 Mineral Resources

Petroleum and CBNG reserves could be considerably depleted by implementation of the Proposed Action or alternatives within the ARPA. The Proposed Action and its alternatives would approve recovery of natural gas resources, which would cause a loss of reserves in the ground. This would generate private and public revenues if drilling leads to petroleum discovery and development.

No economical locatable mineral resources have been identified in the ARPA. Demand for local sand, gravel, and clinker (disposed of through the mineral materials program) for building

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

materials for roads, well pads, and other ancillary facilities may increase. Currently permitted sources are considered adequate to meet the demand for mineral materials. Although there is the potential for mining uranium within the ARPA, no development is expected in the near future. The potential for other mineral development, including locatables (gold and other minerals) or coal, is considered low.

4.1.1.3 Paleontology

Excavation of pipeline trenches and construction of well pads, access roads, and ancillary facilities associated with the Proposed Action or its alternatives could result in the exposure and possible destruction of fossil resources of scientific significance either directly as a consequence of construction or indirectly as a result of increased erosion rates. Increased access resulting from development may increase the visibility of fossil resources and lead to increased poaching.

Conversely, excavation of pipelines and construction of project facilities could result in the discovery of new fossil resources. If these newly discovered resources are properly recovered and catalogued into the collections of a museum repository, the Proposed Action and its alternatives could result in a better understanding and knowledge of this resource. In addition, increased access would allow easier access by professional, permitted paleontologists and geologists, who hope to make scientifically significant discoveries.

The magnitude of impacts associated with the loss of fossil resources associated with the Proposed Action or its alternatives would be reduced by the implementation of paleontologic resource mitigation measures described in appendix H and section 4.1.5.3.

4.1.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with geology, mineral, and paleontology resources:

- To provide opportunity for leasing, exploration, and development of oil and gas while protecting other resource values and
- To maintain the integrity of the scientific value of paleontological resources.

The significance criteria for geology, minerals, and paleontology are the following:

1. Impacts to geology would be significant if project implementation results in increased runoff and erosion, leading to mass movement (including landsliding), subsidence, flooding, increased erosion, or in some cases increased deposition or siltation.
2. Depletion of petroleum and CBNG reserves from subsurface reservoirs resulting from the Proposed Action or its alternatives could be considered an impact.
3. Impacts to paleontological resources would be significant if scientifically important fossils are damaged or destroyed directly or indirectly as a result of the Proposed Action or its alternatives.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.1.3 Direct and Indirect Impacts

4.1.3.1 Proposed Action

Geology

Direct impacts to geology as a result of the Proposed Action would include damage to the surface environment such as alteration of existing local topography that directly or indirectly causes increased risk of mass movements (including landslides) or results in flooding or accelerated erosion or deposition. Indirect impacts to geology would include increased erosion that, if unmitigated, would increase the risk of mass movements including landslides.

Mineral Resources

Other than petroleum and CBNG reserves, inventory of mineral resources in the ARPA revealed no known mineral resources that would be directly or indirectly impacted by implementation of the Proposed Action. Successful field development would result in the ultimate recovery of the natural gas resource from the target formations, under economic conditions favorable to development, and substantially increase petroleum and CBNG. This assumes federal and state permits would be issued for the wells necessary for an efficient operation.

Construction-grade materials are likely to be used from local, as-yet unidentified sources. If development is extensive, local materials may become depleted and additional sources outside of or within the ARPA would need to be identified and used.

Paleontology

Direct impacts to fossils would include damage or destruction of important fossils during construction, with subsequent loss of scientific information. The Proposed Action could result in direct and indirect impacts to fossil resources caused by surface disturbance, especially if disturbances affect geological formations documented in chapter 3 to have a high potential to contain fossils of scientific importance (BLM Paleontology Condition 1 and 2 and Probable Fossil Yield Classes 4 and 5).

However, excavation could reveal fossils of scientific significance that would otherwise have remained buried and unavailable for scientific study. If newly-discovered fossils are properly collected and catalogued into the collections of a museum along with associated geologic data, they would be available for future scientific study. In this way significant consequences, could result from the unanticipated discovery of previously unknown potentially scientifically significant fossils.

4.1.3.2 Alternative A (No Action)

No impacts to geology, minerals, and paleontology would occur under Alternative A.

4.1.3.3 Alternative C

Alternative C would use a more-intensive approval process that might lead to the identification of areas where multiple resources are impacted and where additional mitigation needs to be implemented (See appendix L). This would lessen disturbance in these areas and reduce the potential effects to geology and paleontology. However restrictions or delays in drilling and production might result in the inability to efficiently drain the reservoir.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.1.3.4 Alternative D

The pace of activities and number of wells drilled under this alternative would be identical to that of the Proposed Action so direct and indirect impacts to geology, minerals, and paleontology remain the same as the Proposed Action. Alternative D would have a goal of limiting disturbance and require successful reclamation during development. The result would be less surface disturbance and unreclaimed land throughout the area. Compared to the Proposed Action, this could reduce the potential effects to geology and paleontology. As with the Proposed Action and Alternative C, to lessen impacts, when paleontological resources are found, work would not proceed until paleontological materials are properly evaluated by a qualified paleontologist.

4.1.4 Impacts Summary

Implementation of the Proposed Action, Alternative C, or Alternative D has the potential for direct and indirect impacts to geology, minerals, and fossil resources. The extent of ground disturbance associated with the Proposed Action, as well as other alternatives, is described in chapter 2 and appendix K. No impacts to the geologic or mineral resources are anticipated under the Proposed Action or Alternatives C or D, with the mitigation discussed in appendix H. Application of this mitigation to all lands (private or public) included in the Proposed Action and its alternatives would further reduce potential direct and indirect impacts to these resources.

The likelihood that significant fossil resources would be damaged or destroyed is reduced with the appropriate pre-disturbance surveys/inventories required in high probability occurrence areas for paleontology (Paleontology Condition 1 and 2 areas and Probable Fossil Yield Class 3, 4, and 5 areas), with case-by-case inventories in these same areas, and as required by mitigation measures identified in appendix H.

4.1.5 Additional Mitigation Measures

4.1.5.1 Geology

Mitigation measures presented in sections 4.3 and 4.4 for soils and water resources would avoid or minimize the potential impacts to the surface geologic environment and lessen the possibility of mass movement, flooding; therefore, no additional mitigation measures are required.

4.1.5.2 Minerals

No additional mitigation measures that would address oil and gas resource depletion are proposed.

4.1.5.3 Paleontology

With implementation of mitigation measures identified in appendix H, no additional mitigation measures are required. In addition, locations found to yield scientifically important fossils would not be reclaimed prior to a review by a qualified paleontologist.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.2 Air Quality

Direct and indirect air quality impacts were analyzed to determine potential near-field and far-field ambient air pollutant concentrations, far-field visibility (regional haze), far-field atmospheric deposition (acid rain), and in-field (within the ARPA) concentrations.

This air quality impact assessment is based on the best available engineering data and assumptions, meteorology data, and dispersion modeling procedures, as well as professional and scientific judgment. Assumptions representing most likely operating conditions were incorporated into the analysis whenever possible. For example, for the far-field analysis, compression in the field was assumed to operate at 90 percent of permitted capacity. Where no reliable, most likely operating projections were available, other parameters were assumed to occur at maximum proposed levels. For example, potential impact assessments for the Proposed Action assume that all proposed wells would be productive (no dry holes).

Air pollution potential impacts are limited by state and federal regulations, standards, and implementation plans established under the Clean Air Act and administered by the applicable air quality regulatory agency—specifically, the WDEQ-AQD and the EPA. Colorado, and other regional states, have similar jurisdiction over potential air pollutant emissions sources in those states, and those sources may have a cumulative potential impact when combined with WDEQ-AQD-regulated sources. The applicable air quality regulatory agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees, and control devices prior to construction and operation. The U.S. Congress (through the Clean Air Act Section 116) authorizes these local, state, and tribal air quality regulatory agencies to establish air pollution control requirements of equal or greater stringency than federal requirements. Any proposed emissions source is required to undergo a permit review by the applicable air quality regulatory agency before construction can begin. The agencies review the specific air pollutant emission sources proposed and, depending upon the magnitude of air emissions and other factors, may require additional site-specific air quality analysis and/or additional emission control measures (including a Best Available Control Technology [BACT] analysis and determination) to ensure protection of air quality.

Under FLPMA and the Clean Air Act, BLM cannot authorize any activity that does not conform to all applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans. An air quality impact assessment technical support document was prepared to document analyses of potential impacts from the proposed development alternatives, as well as other reasonably foreseeable emission sources within a defined cumulative analysis area. The Atlantic Rim Natural Gas Project and the Seminole Road Gas Development Project Air Quality Technical Support Document (appendix F) provides additional detail on this air quality evaluation and is available for review at the BLM RFO.

4.2.1 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with air quality resources:

- To prevent the deterioration of air quality beyond applicable local, state, or federal standards, and to enhance air resources where practicable and

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

- To prevent impairment of important scenic values that may be caused by declining air quality.

The significance criteria for potential air quality impacts include state and federally enforced legal requirements to ensure that air pollutant concentrations would remain within specific allowable levels, as well as adherence to the aforementioned RMP and land use plan goals and objectives. Potential impacts are considered significant if:

1. Potential total near-field concentrations are greater than WAAQS or NAAQS;
2. Potential total far-field concentrations are greater than applicable state ambient air quality standards or NAAQS;
3. Potential cumulative near-field concentrations are greater than PSD Class II increments;
4. Potential cumulative far-field concentrations in parks and wilderness areas in the region are greater than PSD Class I increments;
5. Potential decrease in visibility in parks and wilderness areas in the region is greater than Federal Land Managers' Air Quality Related Values Workgroup (FLAG), USDA-FS, or NPS thresholds;
6. Potential decrease in ANC in sensitive lakes in the region is greater than levels of acceptable change LAC;
7. Potential increases in deposition from the project are greater than deposition analysis thresholds (DAT); or
8. Potential cumulative total deposition is greater than USDA-FS levels of acceptable change.

Legal requirements include the NAAQS and WAAQS, which set maximum limits for several air pollutants, and PSD increments, which limit the incremental increase of certain air pollutants (including nitrogen dioxide [NO₂], PM₁₀, and sulfur dioxide [SO₂]) above legally defined baseline concentration levels. These standards and increments were presented in table 3-6.

4.2.2 Direct and Indirect Impacts

4.2.2.1 Analysis Assessment of Direct and Indirect Impacts

This NEPA analysis compares potential air quality impacts from the Proposed Action and alternatives to applicable ambient air quality standards and PSD increments, but comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern for potential impacts, and do not represent a regulatory PSD Increment Consumption Analysis. Even though most of the development activities would occur within areas designated PSD Class II, the potential impacts on regional Class I areas are to be evaluated. For a new source review air quality permit application for a major source, the applicable air quality regulatory agencies may require a regulatory PSD increment analysis. More stringent emission controls beyond BACT may be stipulated in the air quality permit if potential impacts are predicted to be greater than PSD Class I or II increments.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Where legal limits have not been established, the BLM uses the best available scientific information to identify thresholds of significant potential impacts. Thresholds of levels of concern have been identified for Hazardous Air Pollutants (HAP) exposure, incremental cancer risks, a "just noticeable change" in potential visibility impacts, and potential atmospheric deposition impacts to sensitive lake water chemistry. These thresholds or levels of concern are described later in this chapter.

Air quality potential impacts from the project would occur from pollutants emitted during construction (due to potential surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well completion and testing, and drilling rig and vehicle engine exhaust) and production (natural gas well-site production equipment, reciprocating pipeline compression engine exhausts, vehicle traffic engine exhausts, and fugitive dust). Pollutants emitted from these activities include PM₁₀, PM_{2.5}, nitrogen oxides (NO_x), carbon monoxide (CO), SO₂, volatile organic compounds (VOCs), and HAPs (benzene, toluene, ethylbenzene, xylene, n-hexane, and formaldehyde). Ozone (O₃) may also develop from NO_x and VOC emissions. The amount of air pollutant emissions during construction and production may be controlled in part by BACT requirements implemented by WDEQ-AQD. Actual air quality potential impacts from these air pollutants would depend on the amount, duration, location, and emission characteristics of potential emissions sources, as well as meteorological conditions (wind speed and direction, precipitation, relative humidity, etc.).

The assessment of direct project potential impacts included a near-field analysis and a far-field analysis. The near-field analysis assessed direct project potential impacts in the immediate vicinity of project activities resulting from a single phase of construction or production reflective of maximum emissions. The far-field analysis assessed direct project potential impacts from field-wide project emissions at in-field locations within the ARPA and at far-field locations (i.e., sensitive Class I and Class II areas). The far-field analysis also assessed regional emission sources located within the model domain illustrated on map M-8 to predict cumulative potential impacts at in-field and far-field locations. While there may be additional gas processing or transmission requirements due to the development of this and other natural gas projects regionally and nationally, the potential effects of these developments are not quantified herein since these developments are speculative and would likely require additional WDEQ-AQD permitting if they eventually are proposed. The near-field and far-field potential impact analyses were completed for the Proposed Action and Alternative A.

Near-Field Analysis

The near-field analysis analyzed direct project potential impacts within the ARPA and used air pollutant emission rates, which were calculated for all phases of construction and production based on WDEQ-AQD guidance. The AERMOD model was used to assess modeled impacts from the phase of either (1) single-well construction or (2) field production that produced the highest emissions. The near-field analysis for PM₁₀, PM_{2.5}, and SO₂ focused on localized modeled impacts from construction and drilling activities at a single well pad. The near-field analysis for NO_x, CO, and HAPs modeled 2,000 developed wells to reflect the maximum number of wells in production, of which 10 percent were considered conventional natural gas wells and the remaining 90 percent CBNG wells. NO_x, CO, and formaldehyde modeling included emissions from 12 compressor stations to be located within the project area: Blue Sky, Brown Cow, Cow Creek, Doty Mountain, Jolly Roger, Muddy Mountain, Red Rim, Sun Dog, and four additional planned stations.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

A near-field analysis of O₃ potential impacts was conducted separately. O₃ is formed through the chemical reaction of NO_x and VOCs within the atmosphere in the presence of sunlight. A nomograph developed from the Reactive Plume Model (RPM) (Scheffe 1988) was used to estimate the maximum ozone potential impacts based on NO_x and VOC emissions generated from the project. Emissions from a representative localized production area consisting of 17 conventional natural gas wells and the Jolly Roger compressor station were used in this analysis.

Acute (short-term) HAP potential impacts were modeled by assuming that a person would not persistently remain at a location closer than 100 meters (328 feet) from a well pad or a compressor station due to site operations safety considerations. Long-term (chronic) health-based HAP potential impacts and long-term (chronic) cancer risk were modeled using the realistic estimate of long-term exposure, which assumed that a person would not be closer than the nearest residence just west of the ARPA, located 5.5 miles from a well pad or compressor site, when averaged over a lifetime. Two estimates of cancer risk were made: (1) one that corresponds to a most-likely-exposure (MLE) over a national residency average of 9 years with some time spent away from home, and (2) one reflective of the maximally-exposed-individual (MEI) residing at one location for a lifetime with no time spent away from home. The estimated cancer risks were calculated based on EPA (1997) unit risk factors for carcinogenic constituents.

Far-Field Analysis

The far-field analysis used the EPA CALMET/CALPUFF modeling system to predict maximum air quality impacts at mandatory federal PSD Class I and other sensitive PSD Class II areas, as well as designated acid-sensitive lakes within these areas. The analysis also included a potential air quality impact assessment at in-field locations within the ARPA to determine maximum concentrations that could occur from all sources operating simultaneously in the field.

The air emissions modeled for project and non-project sources in the far-field analysis are presented in table 4-1. The modeling scenario developed for the Proposed Action assumed the maximum field emissions that could potentially occur concurrently during the final year of construction representing the maximum annual construction activity rate combined with nearly full-field production. Maximum emissions scenarios include production emissions (producing well sites and ancillary equipment including compressor stations) and construction emissions (drilling rigs and associated traffic), both occurring continuously over the year. Compressor stations were modeled at currently known or anticipated locations within the ARPA, and well sites and construction activities were modeled evenly throughout the entire ARPA. Details on modeling methodology are presented in the Air Quality Technical Support Document (appendix F).

Predicted pollutant concentrations were compared to applicable ambient air quality standards, PSD Class I and Class II increments, and were used to assess potential impacts to AQRVs—visibility (regional haze) and atmospheric deposition—at sensitive PSD Class I and II areas. The PSD Class I areas and sensitive Class II areas analyzed in the far-field analyses include:

- The Bridger Wilderness Area (Class I),
- The Fitzpatrick Wilderness Area (Class I),
- The Popo Agie Wilderness Area (Class II),
- The Wind River Roadless Area (Class II),
- The Mount Zirkel Wilderness Area (Class I),

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

- The Rawah Wilderness Area (Class I),
- The Savage Run Wilderness Area (Federal Class II, Wyoming Class I),
- Rocky Mountain National Park (Class I), and
- Dinosaur National Monument (Federal Class II, Colorado Class I [SO₂ only]).

Table 4-1. Project and Non-Project Emissions (Tons/Year) Included in Far-Field Analysis.¹

Source Category	NO _x	SO ₂	PM ₁₀	PM _{2.5}
Project Sources				
Proposed Action	1,278.5	58.2	780.4	170.6
Alternative A (No Action)	0.0	0.0	0.0	0.0
Non-Project Sources				
RFD	6,224.2	55.5	48.1	48.1
RFFA	4,568.8	-1,394.3	-833.6	-330.0
State-permitted	2,868.0	118.2	-14.8	-133.1

Note:

¹ Non-project emissions sources (RFD and RFFA) are described in section 4.2.3

Because emissions sources under the Proposed Action consist of many small sources spread out over a large area, discrete visible plumes are not likely to impact the distant sensitive areas. However, visible plumes may be noticeable within the ARPA and from nearby travel routes, especially during flaring upset conditions. Nonetheless, the potential for cumulative visibility potential impacts (increased regional haze) is a concern. Regional haze is caused by light scattering and light absorption by fine particles and gases. Potential changes to regional haze are calculated in terms of a perceptible "just noticeable change in visibility" when compared to background conditions. The BLM considers that a 1.0 dv change would be a reasonably foreseeable significant impact, although there are no applicable local, state, tribal, or federal regulatory visibility standards. Other federal agencies are using a 0.5 dv change as a screening threshold for significance. The USDA-FS and NPS compare direct project potential impacts to the 0.5 dv level and those comparisons are included in the Air Quality Technical Support Document (appendix F).

The NPS, USDA-FS, and USFWS have published the FLAG Phase I Report (FLAG 2000) that prescribes a process for assessing the potential impacts of new and existing sources on AQRVs including visibility. The FLAG Report describes a cumulative potential impacts analysis of new growth sources (defined as PSD increment-consuming sources) on visibility. If visibility impairment from a proposed new source, in combination with cumulative new source growth, is less than an extinction of 10 percent (1.0 dv) for all days, the federal land managers would likely not object to the proposed new source. However, if predicted visibility impacts are above the visibility threshold, factors such as the magnitude of dv change, frequency, seasonal variations, and meteorological conditions may be considered when assessing the significance of predicted impacts.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

A 1.0-dv change is considered a small but noticeable change in haziness as described in the EPA regional haze regulations (40 CFR §51.300). One dv is defined as approximately equal to a 10-percent change in the extinction coefficient (corresponding to a 2–5-percent change in contrast for a black target against a clear sky at the most optically sensitive distance from an observer). This is a small but noticeable change in haziness under most circumstances when viewing scenes in mandatory Class I areas. However, this NEPA analysis is not designed to predict potential visibility impacts for specific views in mandatory Class I areas based on specific project designs, but to rather characterize reasonable foreseeable visibility conditions that are representative of a large geographic region based on reasonable emission source assumptions. This approach is consistent with the nature of regional haze and the requirements of NEPA.

Potential changes in regional haze at PSD Class I and sensitive PSD Class II areas were estimated by comparing CALPUFF modeled impacts to background visibility conditions in the Class I or sensitive Class II area. This comparison was performed using two different representations of background visibility conditions. One method used visibility values provided in the FLAG Report for each Class I area to represent natural background visibility. The second method used estimated background visibility values from an analysis of recent long-term monitored data (1988–2002) from the IMPROVE program. This analysis consisted of estimating visibility parameters for representative Class I areas corresponding to the monitoring period of record quarterly average of the 20 percent best visibility days.

Fourteen lakes within the sensitive PSD Class I and Class II Wilderness Areas were identified as being sensitive to atmospheric deposition. These lakes are those for which the most recent and complete data are available, and include:

- Deep Lake in the Bridger Wilderness Area,
- Black Joe Lake in the Bridger Wilderness Area,
- Hobbs Lake in the Bridger Wilderness Area,
- Upper Frozen Lake in the Bridger Wilderness Area,
- Lazy Boy Lake in the Bridger Wilderness Area,
- Ross Lake in the Fitzpatrick Wilderness Area,
- Lower Saddlebag Lake in the Popo Agie Wilderness Area,
- West Glacier Lake in the Glacier Lakes Ecosystem Experiments Site (GLEES),
- Lake Elbert in the Mount Zirkel Wilderness Area,
- Seven Lakes in the Mount Zirkel Wilderness Area,
- Summit Lake in the Mount Zirkel Wilderness Area,
- Island Lake in the Rawah Wilderness Area,
- Kelly Lake in the Rawah Wilderness Area, and
- Rawah Lake #4 in the Rawah Wilderness Area.

The NPS (2001) has identified DATs for total nitrogen and sulfur deposition in the western U.S., which are defined as 0.005 kg/ha-yr for both N and S. The DAT is used as an analysis threshold for evaluating the potential impacts from project-related emissions. The exceedences of this threshold trigger a management concern, but are not necessarily indicative of an adverse impact (NPS 2004). The USDA-FS (Fox et al. 1989) has defined 5 kg/ha-yr for sulfur and 3 kg/ha-yr for nitrogen as LOCs for potential total deposition impacts, and these are used for comparison of potential impacts from cumulative source emissions. It is understood that the USDA-FS no longer considers these LOCs to be protective; however, in the absence of alternative FLM-approved values, comparisons to these levels are made. The USDA-FS Rocky

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Mountain Region has also developed a screening method (USDA-FS 2000) that identifies a LAC in lake chemistry. The LACs are (1) no more than a 10-percent change in ANC for lakes with an existing ANC of 25 $\mu\text{eq/L}$ or greater and (2) no more than a 1- $\mu\text{eq/L}$ change for extremely acid sensitive lakes where the existing ANC is below 25 $\mu\text{eq/L}$. Of the fourteen lakes identified by the USDA-FS as acid sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive.

4.2.2.2 Proposed Action

Near-Field Impacts

The single phase of construction or production proposed as part of the Proposed Action that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of the Proposed Action modeled were PM_{10} and $\text{PM}_{2.5}$ during construction of a well pad; SO_2 from drilling activities; and NO_2 , CO, and HAP from production wells and compressor stations.

The predicted impacts of NO_2 , CO, SO_2 , PM_{10} , $\text{PM}_{2.5}$, and O_3 are presented in table 4-2 for comparison to the NAAQS and WAAQS. As discussed in section 3.2.2, as of June 15, 2005 there is no federal or state 1-hour ozone standard that applies to Wyoming, and as of December 18, 2006 the 24-hour $\text{PM}_{2.5}$ standard will be lowered to 35 micrograms per cubic meter ($\mu\text{g/m}^3$). In addition, the number of allowable exceedances for the 24-hour $\text{PM}_{2.5}$ standard will increase from one to seven (on average over three years). Therefore, BLM will now compare the eighth maximum predicted 24-hour $\text{PM}_{2.5}$ impact to the NAAQS as a "threshold of significance." The second maximum predicted 24-hour $\text{PM}_{2.5}$ impact is shown on table 4-2 and is below the new standard to be applied this December.

Maximum predicted concentrations of NO_2 , CO, SO_2 , PM_{10} and $\text{PM}_{2.5}$ were added to the ambient background pollutant concentrations, provided in table 3-6, for comparison to ambient standards. O_3 maximum predicted concentrations were added to the average hourly background O_3 conditions monitored as part of the Green River Basin Visibility Study (ARS 2002) versus second high maximum values as presented in table 3-6. The average value ($75.2 \mu\text{g/m}^3$) is consistent with (slightly higher than) the background ozone concentration of $62.6 \mu\text{g/m}^3$ that was used in the RPM modeling to derive the Scheffe nomograph. In addition, the Scheffe method is a screening level modeling tool, and as such, it is overly conservative to add highest, second highest measured concentrations to screening level estimates.

Table 4-2. Maximum Predicted Near-Field Impacts from Project Sources—Comparison to Ambient Air Quality Standards, Atlantic Rim Natural Gas Project.

Pollutant	Averaging Period	Maximum Predicted Impact of All Phases ($\mu\text{g/m}^3$)	Background Concentration ($\mu\text{g/m}^3$)	Total Predicted Impact ($\mu\text{g/m}^3$)	NAAQS/WAAQS ($\mu\text{g/m}^3$)	Percent of NAAQS/WAAQS
NO_2	Annual	11.5	3.4	14.9	100	15
PM_{10}	24-Hour	20.8	33	53.8	150	36
	Annual	3.7	16	19.7	50	39
$\text{PM}_{2.5}$	24-Hour	7.0	13	20.0	65	31
	Annual	1.0	6	5.0	15	33
CO	1-Hour	222.6	3,336	3,559	40,000	9
	8-Hour	85.9	1,381	1,467	10,000	15

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Table 4-2. Maximum Predicted Near-Field Impacts from Project Sources—Comparison to Ambient Air Quality Standards, Atlantic Rim Natural Gas Project.

Pollutant	Averaging Period	Maximum Predicted Impact of All Phases ($\mu\text{g}/\text{m}^3$)	Background Concentration ($\mu\text{g}/\text{m}^3$)	Total Predicted Impact ($\mu\text{g}/\text{m}^3$)	NAAQS/WAAQS ($\mu\text{g}/\text{m}^3$)	Percent of NAAQS/WAAQS
SO ₂	3-Hour	20.2	132	152.2	1,300	12
	24-Hour	9.7	43	52.7	365 / 260	14 / 20
	Annual	3.2	9	12.2	80 / 60	15 / 20
O ₃	1-Hour	23.0	75.2	98.2	235	42
	8-Hour	16.1	75.2	91.3	157	58

Predicted impacts from Proposed Action source emissions were shown to be below the applicable WAAQS and NAAQS. Table 4-3 presents a comparison of maximum predicted NO₂ impacts to the PSD Class II increment for NO₂. All NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD increment consumption analysis.

Table 4-3. Maximum Predicted Near-Field Impacts from Project Sources—Comparison to PSD Increments.

Pollutant	Averaging Period	Maximum Predicted Impact of All Phases ($\mu\text{g}/\text{m}^3$)	PSD Class II Increment ($\mu\text{g}/\text{m}^3$)
NO ₂	Annual	11.5	25

When reviewing the predicted near-field impacts, it is important to understand that the results reported reflect the maximum pollutant emission rates calculated for the field and that the resulting concentrations are combined with monitored background ambient pollutant concentrations. Monitored background air pollutant concentrations were assumed to occur throughout the life-of-project at all locations year-round. In addition, the maximum predicted air quality impacts from ARPA emission sources would occur in the vicinity of the ARPA because potential impacts typically lessen with distance from an emissions source; potential impacts at locations more distant from the ARPA would be less than the predicted maximum concentrations. Finally, total air pollutant concentrations were assumed to be the sum of the maximum modeled concentration and the background concentration. This methodology is used for both long-term and short-term averaging periods. For short-term averaging periods, these maximum concentrations may occur under very different meteorological conditions and may not occur simultaneously.

Table 4-4 summarizes modeled HAP impacts based on emissions representative of the Proposed Action. All modeled acute and chronic impacts are below applicable health-based guidelines for the non-cancer compounds. Calculated cancer risk from formaldehyde and benzene are shown in table 4-5. Both the incremental risk from benzene and formaldehyde and the combined risk are less than the level of acceptable cancer risk of 1×10^{-6} for both the MLE and MEI scenarios.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Far-Field Impacts

Impacts from the Proposed Action maximum emissions scenario, which includes the last year of field construction, and nearly the full field in production, were modeled with CALPUFF. The emissions modeled are provided in table 4-1. The maximum predicted concentrations, when added to ambient background pollutant concentrations, are below all applicable WAAQS, California Ambient Air Quality Standards (CAAQS), NAAQS, and PSD increments.

Direct visibility potential impacts from Proposed Action sources were predicted to be below the "just noticeable visibility change" (1.0 dv) at all sensitive wilderness areas using both the FLAG and IMPROVE background visibility data. The maximum predicted visibility change (0.2 dv) was predicted to occur at both the Savage Run Wilderness Area (both FLAG and IMPROVE background data) and Dinosaur National Monument (IMPROVE data only).

Direct project source emissions from the Proposed Action would result in an ANC change less than the LAC at analyzed acid-sensitive lakes. The predicted maximum sulfur and nitrogen deposition potential impacts from Proposed Action sources are below the 0.005 kg/ha-yr DAT at all the sensitive PSD Class I and Class II areas.

Table 4-4. Maximum Modeled HAP Impacts from Project Sources.

Hazardous Air Pollutant	Averaging Period	Maximum Modeled Impact ($\mu\text{g}/\text{m}^3$)	Health Based Standards (Acute RELs and RfCs) ($\mu\text{g}/\text{m}^3$)
Benzene	1-Hour	926	1,300
	Annual	0.02	30
Toluene	1-Hour	1,414	37,000
	Annual	0.03	400
Ethylbenzene	1-Hour	154	35,000
	Annual	0.003	1,000
Xylenes	1-Hour	823	22,000
	Annual	0.02	430
n-Hexane	1-Hour	3832	39,000
	Annual	0.08	200
Formaldehyde	1-Hour	11	94
	Annual	0.003	9.8

Notes:

RELs – Reference Exposure Limits

RfCs – Reference concentrations for chronic inhalation

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Table 4-5. Long-term MLE and MEI Cancer Risk Analyses.

Analysis	HAP Constituent	Modeled Concentration ($\mu\text{g}/\text{m}^3$)	Unit Risk Factor $1/(\mu\text{g}/\text{m}^3)$	Exposure Adjustment Factor	Cancer Risk
MLE	Benzene	0.019	7.8×10^{-6}	0.0949	1.39E-08
	Formaldehyde	0.0030	1.3×10^{-5}	0.0949	3.66E-09
Total Combined Risk					1.8×10^{-8}
MEI	Benzene	0.019	7.8×10^{-6}	0.71	1.04E-07
	Formaldehyde	0.0030	1.3×10^{-5}	0.71	2.74E-08
Total Combined Risk					1.3×10^{-7}

In-Field Impacts

The CALPUFF model was also used to predict maximum air quality impacts from field-wide emissions sources at locations within and adjacent to the ARPA. The model-predicted concentrations of NO_2 , SO_2 , PM_{10} , and $\text{PM}_{2.5}$ at locations within and nearby the ARPA were added to monitored background concentrations and compared to applicable ambient air quality standards. The estimated project-related potential impacts are below applicable ambient air quality standards.

4.2.2.3 Alternatives A, C, and D

Air quality impacts in the ARPA would continue under the No Action Alternative (Alternative A) from previously approved natural gas development activities and could potentially occur under Alternatives C or D in the future. However, air impacts from each of these three alternatives would be less than or equivalent to the Proposed Action. Thus, none of the impacts would exceed the significance criteria in section 4.2.1.

4.2.3 Air Quality Monitoring and Mitigation

Potential air quality impacts from the Atlantic Rim project were estimated to be below applicable air quality standards (table 4-2). Potential O_3 concentrations were estimated by the Scheffe method, which was considered by the inter-agency air quality team to be a reasonable tool and an acceptable ozone method at the time the air quality analyses was conducted.

4.2.3.1 Monitoring

WDEQ established an air quality monitoring station on land owned by Anadarko Petroleum near Wamsutter, Wyoming in March of 2006 to monitor concentrations of NO_x , O_3 , PM_{10} and SO_2 . In cooperation with WDEQ, the Operators would finance and operate additional air quality concentration monitoring, including O_3 , in the RFO area. BLM would work cooperatively with WDEQ, EPA and the operators to maintain and enhance concentration monitoring in the RFO area, including monitoring required to represent impacts due to emissions from the Atlantic Rim field.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.2.3.2 Mitigation

If in the future air monitoring were to show O₃ exceedances that were attributable at least in part to sources in the Atlantic Rim field, BLM would consult with WDEQ and EPA to determine whether adaptive management would be needed to mitigate impacts.

4.3 Soils

4.3.1 Introduction

Potential impacts resulting from construction/installation of drill pads, pipelines, ancillary facilities, and access roads would include:

- Loss/reduction of vegetation cover and biological soil crusts,
- Exposure of vulnerable sub-surface soil profiles,
- Loss/reduction of sub-surface biological components (i.e., earthworms, nematodes),
- Undesirable mixing of soil horizons,
- Soil compaction, and
- Loss of topsoil productivity.

These impacts, singly or in combination, would increase the potential for valuable soil loss due to increased water and wind erosion, invasive/noxious/poisonous plant spread, invasion and establishment, and increased sedimentation and salt loads to the watershed system.

4.3.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state land use plans (WSLUC 1979) prescribe the following management objectives associated with soil resources:

- To maintain soil cover and productivity where they are adequate and to increase soil cover and productivity where they are in a downward trend and
- To maintain or improve soil stability, within the potential of the ecological site, to insure adequate water infiltration, optimal plant growth, and minimal surface runoff.

The following criteria serve as a basis to assess the intensity, duration, and magnitude of potential soil impacts associated with implementation of the Proposed Action and action alternatives. Soil impacts would be significant given the following:

1. Soil loss greater than 2 tons per acre per year above base levels in areas attributed to surface disturbance after reclamation,
2. Interim reclamation is unsuccessful within 5 years of implementation, or
3. Soil productivity is reduced to a level that prevents the disturbed area from recovering to pre-disturbance soil/vegetation productivity levels.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.3.3 Direct and Indirect Impacts

4.3.3.1 Proposed Action

Construction and operation of wells, pipelines, roads, and facilities in the ARPA associated with the Proposed Action would result in impacts to the soil resource by:

- Removal/damage of existing native vegetation and surface litter thus increasing wind erosion potential, increasing raindrop impacts to exposed soils and water erosion potential, and increasing soil surface temperature;
- Removal/damage of biological soil crusts;
- Removal/damage of topsoil and sub-soil fauna (macro- and microorganisms);
- Compaction of soils;
- Mixing of topsoil horizons, especially when mixed with sub-soils of high salt content; thus increasing topsoil salinity content;
- Increasing potential for undesirable (invasive/noxious/poisonous) plant invasion and establishment;
- Increasing potential for sedimentation/salt loads to the watershed, including stock ponds; and
- Decreasing topsoil productivity.

As described in section 3.3, most soils in the ARPA have been mapped and sensitive soils identified. Implementation of the Proposed Action may occur in/on soils that have severe existing limitations. Table 3-10 summarizes the total area (acres) that may be affected by these limiting factors identified in the ARPA.

Because soil mapping units indicate sensitive soils are widely distributed throughout the ARPA, total avoidance of these areas is not feasible. Minimizing or avoiding all together the construction of ancillary facilities in areas identified to contain sensitive soils would reduce impacts to an acceptable level. Strict adherence to Required Best Management Practices (appendix H), the RMP, Best Management Practices for Non-Point Source Pollution (appendix J), and the Reclamation Plan (appendix B) would minimize impacts to sensitive soils.

Over the estimated 20-year development phase, the Proposed Action is estimated to disturb a total of 15,800 acres which represents about 6 percent of the total land surface of the project area. During the projected 30–50 year life-of-project, the initial disturbed acreage would be gradually reduced to about 6,200 acres dependent upon time required for successful reclamation. Approximately 1,170 total well locations would be developed in the first 6 years. The entire project area would be developed over a 20-year period, with approximately 90 percent of the CBNG wells and 75 percent of the conventional wells being drilled within 15 years.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

A large portion of the project area would be difficult to re-vegetate due to high erosion hazard potentials and poor topsoil. Some areas of clayey soils, sandy soils, and slopes greater than 25 percent would be avoided by final site selection during the on-site inspections for each year's development plan.

In general, the extent of these impacts to the soil resource would be influenced by the success of mitigation and reclamation efforts. Reclamation success, in part, depends on the amount of surface area disturbed, quality of topsoil salvaged, stockpile/redistribution methods in disturbed areas, precipitation, soil type, and moisture availability.

Despite the difficulty of establishing vegetation on sites with less than 10 inches average annual precipitation, current technology exists to stabilize these areas and minimize soil erosion as natural succession returns the site to pre-existing conditions. The reclaimed areas within the interim drilling pods have not shown this success to date. There are many disturbed areas with increased erosion, weed infestations, and low native vegetation cover. Erosion could be reduced and reclamation success improved, assuming construction, maintenance and operation of well pad sites and associated disturbances are in accordance with mitigation measures summarized in appendix H, BMPs, and RMP requirements. An increased pace of development would intensify the rate of soil exposed and the need for reclamation. Many areas would exceed the significance criteria for soils; therefore the project would exceed the significance criteria.

Surface-disturbing activities have the potential to disturb or destroy biological soil crusts, if they are present. Loss of biological soil crusts by burying is inevitable with road construction, trenching, and other operations that remove vegetation and top soil. Disturbance to biological soil crusts can be minimized by limiting off-road vehicle activity (especially heavy construction equipment, trucks, pickup, and cars). Vehicle tracks often channel water resulting in slowing or preventing crust recovery and increasing erosion potential. Vehicles with high-flotation tires (e.g., all-terrain vehicles or ATVs) exert less force to the soil surface but may still disrupt crusts by rapid turns which shear the topsoil. A single pass across soils by a vehicle can crush biological soil crusts resulting in a long-term loss; the length of time necessary to allow recovery is estimated at 50–100 years (Belnap et al. 2001). If crusts are removed or buried, recovery time is anticipated to be longer.

4.3.3.2 Alternative A (No Action)

Under the no action alternative, direct and indirect disturbance of soil and crusts would continue under already approved actions, until those projects are completed. The remainder of the project area soils would remain unaffected. Reclamation, erosion, and weed control during the interim drilling period to date is a concern based on current reclamation success. BLM will focus on adaptive management of disturbance to improve reclamation success.

4.3.3.3 Alternative C

Implementing Alternative C would have similar impacts to the Proposed Action, but additional mitigation proposed for soils and other resources would limit the initial disturbance acres on sensitive sites to less than 20 acres and four well pads per section. Examples of some sensitive sites are soils with high runoff potential and big game crucial winter range. These mitigation measures would reduce the total acres disturbed by 68 percent on areas with federal minerals

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

ownership compared to the Proposed Action. Other mitigation measures proposed would further reduce erosion from disturbed sites.

These benefits would be realized to the greatest extent in the central and southern portions of the ARPA where there is a preponderance of BLM lands. The extreme southern portion and the northern half would realize some benefit of these additional mitigations, but their effectiveness would be reduced due the lack of equivalent mitigation on private and state lands.

Alternative C will not only reduce effects based on lower surface disturbance extents, but also due to the influence of the other development protection measures and the reduced number of siting choices that need to be made. Where only 4 well pads per section are allowed, the best four would be chosen as compared to finding 8 locations per section.

This reduction in disturbance acres and application of development protection measures would directly reduce the acreage and environmental impacts of this alternative which would not exceed the significance criteria as a result of the project. Although some localized areas still would exceed the criteria, overall, the project would not exceed the significance criteria.

4.3.3.4 Alternative D

Implementing Alternative D would have a goal of limiting the acreage disturbed compared to the Proposed Action of an average of approximately 20 percent across the ARPA and more within Category A areas (map M-7). Total disturbance acres would be reduced compared to the Proposed Action, but with very little disturbance in avoidance areas. Alternative D would establish a project-wide surface disturbance goal of 6.5 acres/well, with a disturbance goal in Category A areas (Map M-7) less than 6.5 acres/well. Soils in avoidance areas would generally be protected, unless influenced by activities adjacent to these sites. Overall, the impacts to soils would be the same as with the Proposed Action, but occur over reduced disturbance acreages and would still exceed the significance criteria.

4.3.4 Impacts Summary

Implementing the Proposed Action or Alternative D, would reduce potential impacts, assuming construction, maintenance, and operation of well pad sites and associated disturbances are in accordance with BMPs and the RMP requirements. Many areas would still exceed the significance criteria for soils; therefore, the project would exceed the significance criteria under these alternatives.

Implementing Alternative C would reduce direct impacts to sensitive soils compared to the Proposed Action, by 68 percent on federal mineral leases (66 percent of the ARPA). This reduction in disturbance acres and application of additional erosion control measures (appendix L) would directly reduce the acreage which would exceed the significance criteria as a result of the project. Although some localized areas still would exceed the criteria, overall, the project would not exceed the significance criteria.

4.3.5 Additional Mitigation Measures

There is no additional mitigation proposed under the Proposed Action or Alternative D. Mitigation measures listed in appendix H apply to all alternatives. Additional mitigation proposed under Alternative C is located in appendix L.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.4 Water Resources

4.4.1 Introduction

The Clean Water Act of 1987, as amended (33 United States Code 1251) established objectives to restore and maintain the chemical, physical, and biological integrity of the nation's water. The act also requires permits for point source discharges to navigable waters of the United States and the protection of wetlands, and it includes monitoring and research provisions for protection of ambient water quality. The State of Wyoming implements permitting and monitoring requirements for the Wyoming Pollutant Discharge Elimination System (WYPDES), operation of injection wells, groundwater protection requirements, prevention and response requirements for spills, and Water Quality Standards for Salinity in the Colorado River system as recommended by the Colorado River Basin Salinity Control Forum and adopted by WDEQ as a member of the forum.

Protection of Wetlands (EO 11990) requires federal agencies to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Floodplain Management (EO 11988) provides for the restoration and preservation of national and beneficial floodplain values, and enhancement of the natural and beneficial values of wetlands in carrying out programs affecting land use. Potential project-related depletions to the Little Snake River are considered with regard to the Yampa River Basin Management Plan and the Upper Colorado River Endangered Fish Recovery Program (1999) for Colorado River native fish downstream from the project area (<http://www.r6.fws.gov/crrip/>).

Surface discharge, as a method of disposal, from Federal Mineral Leases is subject to BLM approval to the point of discharge. Once surface discharge is approved, the operations from the point of discharge downstream are under the jurisdiction of the State of Wyoming.

All produced water from Federal/Indian leases must be disposed of by (1) injection into the subsurface; (2) into pits; or (3) other acceptable methods approved by the authorized officer, including surface discharge under NPDES permit. Injection is generally the preferred method of disposal. Operations from the point of origin to the point of discharge are under the jurisdiction of the BLM. Operations from the point of discharge downstream are under the jurisdiction of EPA or the Primacy State. 43 CFR 3162.5-1(b)

Some of the regulations described above require that certain permits/authorizations be obtained from the State of Wyoming, the BLM or other Federal Agencies including WYPDES permits for surface discharge of produced water; Applications for Permits to Drill, Federal Lease Obligations, development of a surface runoff, erosion, and sedimentation control plans; injection well permitting; oil spill containment and contingency plans; as well as Clean Water Act (CWA) Section 404 permits in the Colorado River and North Platte River Drainage Basins.

For the purposes of this analysis, the Proposed Action and the alternatives assume adherence to these plans, permits, leases and regulations for the protection of water resources. Many potential impacts associated with gas development are common to all alternatives and therefore are analyzed for general impacts in section 4.4.3. As these impacts vary by alternative and can be expanded on they are discussed in relation to each alternative.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.4.1.1 Surface Water Impacts

Potential impacts that may occur to the surface water system due to the proposed project include increased surface water runoff, wind erosion, and off-site sedimentation due to soil disturbance associated with construction activities (section 4.3), water quality impairment of surface waters, and stream channel morphology changes due to road and pipeline crossings. The magnitude of the impacts to surface water resources would depend on the proximity of the disturbance to a drainage channel, slope aspect and gradient, degree and area of soil disturbance, soil character, and duration of time within which construction activities occur, and the timely implementation and success/failure of mitigation measures. Impacts would likely be greatest shortly after the start of construction activities and would likely decrease in time due to stabilization, reclamation, and revegetation efforts (See appendices B, H, and J). Changes in surface flow patterns from road construction would continue through the life of the project and may extend beyond the project life if these roads are left in place. Petroleum products and other chemicals could be accidentally spilled resulting in surface water contamination. If these spills occur, they would be addressed with the Hazardous Materials Management Plan (appendix C).

4.4.1.2 Groundwater Impacts

The primary effects on groundwater resources would be associated with the removal of groundwater contained in coal aquifers and the subsequent recharge of aquifers through injection of produced water. The removal of groundwater from the coal aquifer results in the reduction of the hydraulic pressure head. The lowering of hydraulic head in an aquifer is also referred to as drawdown. The effects would result in progressive drawdowns within nearby wells completed in the same coal bed aquifers or in other aquifers hydrologically connected to the coalbeds. Impacts may include the interruption of groundwater flow to existing nearby springs, seeps, and flowing artesian wells. Another impact of the proposed project on groundwater resources would be an increase in the hydraulic pressure head in the aquifers receiving the injected coal bed water.

4.4.1.3 Assumptions for Analysis

Under all alternatives, the following would be adhered to: applicant committed measures (described in appendix K), required BMPs (appendix H), and BMPs for Non-Point Source Pollution (appendix J) as applicable, as well as the regulation and plans described in section 4.4.1. As per NEPA guidance, this analysis will be based on the premise that standard operating procedures including these BMPs and regulations will be adhered to under each alternative. The ARPA contains several active gas fields. There are 205 (116 are CBNG) active producing natural gas wells with accompanying production-related facilities, roads, and pipelines (<http://wogcc.state.wy.us/>). There are also abandoned well sites that in some cases are not fully reclaimed, the number of which is difficult to estimate. While the ARPA environmental analysis was being prepared, 116 CBNG were drilled in six POD locations to determine the feasibility of full-field development.

Approximately 80 percent of the ARPA is within the Colorado River Basin, with 69 percent lying within the Muddy Creek drainage area, 17 percent within the Great Divide Basin, and 3 percent within the Missouri River Basin. Table 3-10 summarizes the data for soil factors of concern and their extent within the ARPA. Table 3-11 shows the five soil categories as they relate to each of the twenty-one, 6th-level HUCs. The HUC boundaries are shown on map M-10.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

The no action alternative (Alternative A) would deny the proposed action. The approved pods would continue to be developed and operated (See table 1-1) under the lease terms and conditions of approval attached to APDs, and in the manner and conditions described in each pod's Environmental Assessment (EA) and decision record. Impacts would be similar to those described in the environmental assessments for the pods. New proposals for developing gas leases in the project area would be considered as they are proposed. If impacts are determined to be significant for these proposals, a new EIS process may be initiated.

All action alternatives assume the construction of up to 2,000 wells and associated roads and pipelines based on the drilling schedule shown on figure 2-1. The specific location of these facilities has not been provided by the operator under any alternative.

The Atlantic Rim project area is 270,080 acres in extent. The proposed action is for 8 wells per section or 80-acre spacing. The ARPA divided by 80-acres equals 3,376 potential well sites for the project area. Only 2,000 wells are proposed by the operators and 116 have been developed during the interim drilling period. Future CBNG development could be at a maximum intensity of 80-acre spacing. This means that approximately 37 percent ($1 - 2,116/3,376$) of the ARPA, 110,800 acres may not experience concentrated development (i.e. 80-acre well spacing). The extent of the unused (or less used) portion of the project area will be defined by the suitability of production of natural gas and may or may not be continuous. These areas without concentrated well locations would potentially experience surface disturbance from roads and pipelines to access wells and could also include areas of less dense conventional well development. The operators have indicated that they will drill at wider spacings when geologic, permeability and other conditions allow, but such areas are unknown at this time. In addition, if drilling and production activities are developed at a wider spacing, more area within the project area could be effected (example: 200 wells at 80 acre spacing effects 1,600 acres while 200 wells at 100 acre spacing effects 2,000 acres).

Specific locations for well sites or areas of concentrated development have not been identified in the proposed action; therefore this analysis will consider impacts throughout the project area. Approximately 166 injection wells are anticipate for the project. Both injection and conventional wells could share pads with CBNG wells (appendix H), although specific locations cannot be predicted. A certain percentage of the conventional well locations will be unsuccessful, and be abandoned and reclaimed; this has been estimated as 35 percent for the Desolation Flats EIS. However, it can be assumed that all the CBNG well locations would be used through the life of the project. This is because CBNG wells that do not produce gas may still be used to remove water from the coalbeds and increase gas production in other wells.

Several regions in the project area may not be developed. For example, the far north pod of (map 3, Pod #1, no name pod) was not developed during the interim drilling period based on results of drilling on private estate. Because there is no information to predict where concentrated development may occur and proposed action does not specify regions that will be more intensively developed, development at 80-acre spacing throughout the project area will be analyzed, except where restricted by BLM alternative(s).

The maximum surface disturbance for the Proposed Action is anticipated to be 15,800 acres or about 6 percent of the project area. With successful reclamation, about 2.3 percent of the project area would be disturbed after reclamation and into the production phase (appendix K, table K-3). Of this disturbance about 66 percent of the development is on federal mineral lands (appendix K, table K-3).

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Produced water disposal will primarily occur via an estimated 166 injection wells. Impacts from any potential new disposal methods not currently occurring within the ARPA will be analyzed in separate project-specific NEPA documents to fully analyze potential impacts.

Wetlands/Riparian and Floodplain areas have been identified along intermittent and perennial waters as well as those associated with springs, seeps and/or wells (map M-16) from NWI, USGS Hydrography data, and site visits to evaluate PFC for range management. Most 100 year floodplain areas would occur within 500 ft. of perennial waters or 100 ft. of ephemeral drainages. These features would be identified during onsite investigations and would be avoided for the location of permanent features. As part of standard oil and gas mitigations, areas within 500 ft. (~1/10 mile) of surface waters, identified 100-yr floodplains, and wetlands are managed for controlled surface use, also called avoidance areas (see appendices J and H).

Alternative C would not allow pad sites in some areas of environmental concern and would institute development protection measures (appendix L) that are based on resource concerns identified using spatial data (GIS). Many of these protection measures are specifically designed to reduce impacts to surface and groundwater resources. Under all alternatives, development protection measures would not apply to private or state lands. Alternative D would limit the amount of unreclaimed disturbance area at any given time to no more than 7,600 acres (See section 2.2.4).

Surface Water Assumptions

The analysis for surface water is based on the following specific assumptions:

- Disturbance to soil and vegetation, including compaction of soil, would increase water runoff and downstream sediment loads, and lower soil productivity thereby degrading water quality, channel structure, and overall watershed health in some locations.
- The degree of impact attributed to any one disturbance or series of disturbances is influenced by several factors including location within the watershed, time and degree of disturbance, existing vegetation, and precipitation.
- Increased pollutants in surface waters would degrade habitat used by aquatic life and would affect other uses (e.g., stock-watering, irrigation, and drinking water supplies).
- BLM would continue to develop and maintain water sources in upland area to reduce impacts on wetland/riparian areas, and provide a resource for livestock grazing.
- Access roads would follow standard construction practices. However, properly designed roads would still alter hillslope hydrology and concentrate overland flow increasing erosion in some areas. In areas with steep topography, roads are expected to be longer resulting in greater impacts to surface water resources.
- Fine-textured soils are more susceptible to water erosion and compaction when wet; whereas, coarse-textured soils are more susceptible to wind erosion (See section 4.3).

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Groundwater Assumptions

For the purposes of this analysis, the no action alternative for groundwater would only consider the impacts of approved development within the project area. This would include 116 CBNG wells drilled during the Interim Drilling Policy (appendix A). The location of these wells would be in the originally approved POD boundaries and would include one injection well for every 12 CBNG wells (about 10 injection wells).

For the purposes of this analysis, potential locations of CBNG wells were estimated to build the groundwater model. Assumptions were made based on the geology and unit boundaries described by the operator early in the process. The groundwater modeling assumptions are discussed in section 4.4.3.

4.4.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with water resources:

1. To meet or exceed established standards for quality of surface water and groundwater where water quality has been lowered by human-induced causes;
2. To reduce salt loading in watersheds that lie within the Colorado River Basin;
3. To maintain riparian areas in good or excellent condition and to improve riparian areas that are in fair or poor condition;
4. To control flood and sediment damage from natural or human-induced causes; and
5. To provide for physical and legal availability of water for use by the public and by federal, state, and, local agencies for fisheries and wildlife and for livestock, recreational, municipal, and industrial uses.

Significance criteria are developed to gauge the magnitude an impact would have on the human environment. An impact on water resources as a result of project actions would be considered potentially significant if its magnitude was such that special mitigation is warranted or it persists indefinitely.

The significance criteria listed in 40 CFR 1508.27 are not necessarily scientifically or factually determined. For example one significance criterion is "the degree to which the possible effects on the quality of the human environment are likely to be highly controversial." For this analysis, the approach to establishing significance criteria was based on legal issues (i.e., government regulatory standards), public perception, available scientific and environmental documentation, and professional judgment of resource specialists, as specified in 40 CFR 1508.27.

4.4.2.1 Surface Water Significance Criteria

Impacts to surface water resources would be considered significant if the following were to occur:

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

1. Degradation of water quality beyond the designated use of the receiving water body, or other violations of federal or state water quality standards or negatively impacting a water body listed on the State 303d list of Impaired or Threatened Waterbodies.
2. Project activities elevate salt loading to the Colorado River system above background conditions.
3. Unmitigated loss of wetlands or wetland function (EO 11990 and 11988).
4. Project-related activities that degrade wetland/riparian areas such that, as a minimum physical state, PFC Standards for Healthy Rangelands (USDI-BLM 1997) are not being maintained.
5. Streamflow characteristics of intermittent drainages or perennial streams are altered such that established uses are affected.
6. Alteration of stream channel geometry or gradient by accelerated runoff and erosion (e.g., undesirable aggradation, degradation, or side cutting) beyond what would be expected by natural processes.

4.4.2.2 Groundwater Significance Criteria

Impacts to groundwater resources or springs caused by project activities would be considered significant if the following were to occur:

1. The natural flow or level of groundwater to existing local springs, seeps, flowing artesian wells or permitted water supply wells is interrupted or reduced, regardless of use or non-use.
2. Groundwater quality in any aquifer is degraded such that it can no longer be classified for its current use(s).
3. Accidental spills of fuels, liquids, chemicals, or hazardous material affects the quality of groundwater.

4.4.3 Direct and Indirect Impacts

4.4.3.1 Direct and Indirect Impacts Common to All Alternatives

There are 2,000 proposed new well pad locations (CBNG and Conventional) under all action alternatives. Under the action alternatives, impacts of individual well pads, roads, pipelines and other infrastructure would have the same individual impacts where mitigation is the same. Under Alternative C additional development protection measures will generally result in reduced effects.

All action alternatives would require the pumping of water from coalbeds in the upper Mesaverde Group from the Almond formation. This would result in lowering the hydrostatic pressure head, creating associated impacts to water resources. These impacts would occur in slightly different locations and at different times depending on the alternative assessed.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Surface Water Impacts Common to All Action Alternatives

The main impacts to surface water resources are the removal of vegetation, increased soil surface exposure, mixing of soil horizons, soil compaction and decreased infiltration capacity, loss of topsoil productivity, and increased susceptibility of the soil to wind and water erosion. Therefore, the primary impact of the proposed project on surface water resources is increased surface runoff, erosion, and off-site sedimentation that would cause channel instability and degradation of surface water quality in some locations.

Martherne (2006) found increased sediment production from well pad locations and confirmed that roads and well pads can provide conditions for focusing runoff and locally increasing erosion. Based on field observations, the author found that roads on sideslopes facilitate the erosional process in three ways: (1) roads cut across and collect runoff from previously established drainages (2) roads, where they are cut into hillsides or into the land surface, provide focal points for the initiation of erosion; and (3) roads also provide conduits for sediment transport. Once mobilized, a portion of this sediment (resulting from these erosional processes) will move into channels in pulses that occur in relation to storm events. Some of this sediment will be temporarily stored in drainage bottoms and on the hillslope and a portion will be stabilized by vegetation and not travel to the drainage. The amount of sediment that will be added to specific drainages can only be estimated based on site-specific information available after annual planning and on-site inspections.

Changes in upland runoff, hydrology, or increased sedimentation could reduce habitat for non-game fish, coldwater fish, and aquatic life, especially in the Muddy Creek Drainage. Habitat for non-game species includes pools and riffles. With increased sediment loads, riffles can become silted in and pools can fill, degrading the habitat. Changes in upland runoff conditions can increase peak flow conditions and may reduce base flows critical for maintaining late season pool habitats.

Waters of the U.S. are managed in section 404 of the CWA and permits from U.S. Army Corps of Engineers (ACOE) may be required for dredge and fill activities. All notification and construction criteria will be adhered to and the ACOE will be consulted when questions about the permit use arise. The Great Divide Basin is unlikely to have any waters of the U.S. because it is internally drained and has no major water based recreation sites. Standard mitigation requiring avoidance of surface waters, riparian areas, and wetlands (See appendix H) will limit surface disturbance in these areas on public land to linear features such as road and pipeline crossings. Activities that modify the morphology of stream channels are also subject to regulation by the State of Wyoming. Permitting for construction activities in these areas would take place during the annual planning process and copies of notices or permits may be required of the operator before construction is approved (See appendix H). The effected environment in special aquatic sites and wetlands are discussed in greater detail in section 3.5.

Surface Hydrology Related to Soils Data and Topography. Soils with the potential for severe water erosion comprise about 96 percent of the ARPA (261,000 acres of slight/severe, moderate/severe, and severe/severe categories, see tables 3-10 and 3-11). Tables 3-10 and 3-11 summarize the data for the following five categories and their individual ranking criteria for the contiguous ARPA: water erosion, wind erosion, runoff potential, topsoil rating, and road rating. Because so much of the ARPA has the potential for severe water erosion, soil disturbance both during construction and during production can be expected to result in hillslope and channel erosion under each action alternative above background conditions. Erosion in areas with sensitive soils can be either catastrophic or simply chronic. Surface disturbance

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

combined with sensitive soils and highly variable precipitation would result in sudden and deeply incised erosion in the form of rilling and gully, even in relatively gentle terrain. This would occur under all action alternatives in some locations.

Soil characteristics such as depth, permeability, runoff rate, water capacity, and susceptibility to erosion vary widely. The diversity of soil parameters would require a broad spectrum of reclamation techniques. In addition, low annual precipitation and wind and water erosion could make successful reclamation in the ARPA difficult to attain. Therefore, the overall potential for successfully stabilizing disturbed soils is poor to fair.

Because specific sites have not yet been identified for wells, pipelines, and roads, tables 3-10 and 3-11 indicate a likelihood of encountering soil limitations that would require special attention. For example, large portion of the ARPA would likely experience difficulties during revegetation due to the presence of excess salts in the soil or poor/fair topsoil rating (maps M-9 and M-13).

Reclamation Success and Roads. It is important to note that even successful reclamation (appendix B) does not necessarily return an area to its previous function for surface hydrology. For example, re-establishing 80 percent of pre-disturbance groundcover in five years would be considered successful. Background groundcover amounts can be estimated at 20-65 percent (groundcover would include rocks and litter in addition to vegetation, i.e. total cover). Perennial forbs, brush, and trees generally are more effective at reducing rain splash and can provide structure on the soil surface that can reduce surface runoff energy, but are generally not required for reclamation. Anderson (1975) in a study of 23 watersheds found that conversion of a steep forest and brush lands to a grassland had multiplied sediment yields by five times. Although this is an extreme case, it points out that not all vegetation is the same hydrologically. Where interim reclamation has been successful, sagebrush and other brush regeneration will occur within the project life; however, many areas would not return to pre-disturbance function until 30–50 years after final reclamation.

New access roads would be constructed for the purpose of natural gas field development. There are three types of roads identified for the project. Collector and local roads are to access multiple well pad locations and resource roads are to access individual well pads. As described in the applicant committed measures (appendix K), roads would be designed to BLM Manual 9113 standards to minimize disturbance, and all surface disturbance would be contained within the road right-of-way (ROW). Where drilling is non-productive, disturbed areas, including the well site and new access roads, would be reclaimed to the approximate landform that existed prior to construction. If drilling is productive, access roads to the well site would remain in place for well servicing activities. Partial reclamation would be completed on segments of the well pad and access road ROW that are no longer needed.

Under all alternatives road construction would modify the surface hydrology by intercepting and concentrating surface runoff, and in certain instances (e.g., a road cut into a hillside) intercept and alter groundwater flow. Road surfaces decrease infiltration and concentrate flows. Roads would also contribute sediment to downstream drainages from the road surface and from surface disturbance based on construction and road maintenance activities. Properly designed roads would be more able to shed water in a non-erosive manner and this would reduce impacts compared to roads that are improperly or inadequately designed. However, even with proper design using BLM Manual 9113 standards, there would be local impacts in terms of erosion and changes in hydrology. Where roads are in steep country or road densities are

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

great, these impacts can be expected to include accelerated erosion and increased runoff and could alter downstream channels.

During drilling and completion operations (according to appendix K, table K-2), roads could be used by about 13 heavy trucks per week for about 2 weeks, and about 5 to 10 small trucks per day. During production, resource roads would be used less often (maybe 1 small truck per day) and would occasionally accommodate heavy trucks for water disposal, reclamation activities, and well maintenance. This means that road design needs to allow for heavy truck traffic and at least one visit per day in all kinds of weather. This amount of road use would likely result in dust production from the road base and would increase wind-born erosion from the project area. Road design and maintenance is therefore critical to reduce impacts from the project.

Site erosion and off-site sedimentation from pad sites would be reduced by re-vegetating unused portions of the pad sites in the first appropriate season (fall or spring) after drilling, and providing surface water drainage controls, such as berms, sediment collection traps, diversion ditches and erosion stops as needed. These measures would be described in individual APDs.

Under all action alternatives, local impacts would include accelerated erosion and increased runoff leading to increased sedimentation and changes in hydrology from surface disturbance for the construction of pad sites, roads, and pipelines. Depending on the alternative considered, these impacts could be significant based on the criteria set forth in section 4.4.2.

Surface Water Quality Impacts from Salinity Offsets. Surface discharge at the Cow Creek Pod can be expected to continue through the life of the project under all alternatives according to the WYPDES permits #WY0042145 and #WY0035858, which allow for 1.34 tons/day of salt and 180,600 gallons/day of total discharge. As an offset for an oil well (as defined by the Colorado River Salinity Control Forum) the permit allows for the same volume of water and salt as was discharged by the plugged oil well (#1X-12).

Discharge is into a reservoir on a tributary to Dry Cow Creek; this reservoir would be improved and maintained according to this use. The discharge permit has been modified to allow for water releases from the reservoir in a similar manner as what occurred historically when #1X-12 was in operation; however, volume restrictions would still be in place. The permit would have a new point of compliance upstream of the confluence with Cow Creek. This point of compliance would be monitored for flow, and according to the permit it should only have water during storm events, that is, in response to natural precipitation and not a result of project discharges because Dry Cow Creek is ephemeral.

The Colorado River Salinity Forum established by the 1974 Colorado River Basin Salinity Control Act (Public Law 93-320) regulates the amount of salt load that can enter the Colorado drainage basin. Current loads approved by the state exceed the 1-ton-per-day limit because of the offset value of plugging #1X-12. Allowing for offsets with volume restrictions limited to historical levels with flowing wells is not expected to have any significant impacts, because project-related discharges would be almost identical to current conditions.

Groundwater Impacts Common to All Alternatives

The primary effects on groundwater resources would be associated with the removal of groundwater contained in coal bed aquifers and the subsequent recharge of aquifers through injection of produced water. The removal of groundwater from the coal aquifer results in the reduction of the hydraulic pressure head. The lowering of hydraulic pressure head or water

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

levels in an aquifer is also referred to as drawdown. The effects of producing water from the Almond Coal Beds would result in progressive drawdowns within nearby wells completed in the same coal bed aquifers or the interruption of groundwater flow to existing nearby springs, seeps, and flowing artesian wells receiving groundwater from the same coal aquifer. Another impact of the proposed project on groundwater resources would be an increase in the hydraulic pressure head in the aquifers receiving the injected coal bed water.

A predicted total project volume of produced water in the best success scenario for the CBNG development would be 250,000 to 450,000 barrels of water per day (bwpd) for approximately six to eight years. However, it should be noted that these volumes are estimates. With the need to remove waters from sands adjacent to the targeted coalbeds, which appear to be in hydrologic connection (See section 3.4.5), these volumes could be higher. Produced water from this project would be disposed of through 166 injection wells completed in the Hatfield, Cherokee or Deep Creek sands in the Haystack Mountains Formation within the Lower Mesaverde Group and underlying the Allen Ridge Formation. Assuming the lowest estimate for injection well efficiency (5,000 bwpd), 166 injection wells should handle 830,000 bwpd (nearly two times the highest estimate of water disposal). The water would be injected into these wells for the life of the project. No cumulative impacts to the target members of the Lower Mesaverde Group would likely occur as a result of this project. If injection capacity is insufficient or water disposal needs are significantly greater than anticipated, additional injection wells or injection wells in other formations may need to be developed.

Groundwater could also be affected during drilling operations. If they were to occur, improper casing and cementing of wells, undetected spills, or leachate from produced water or mud pits could introduce contaminants into the groundwater. Chemicals used for production drilling could cause local contamination of soils and groundwater if not managed properly. Construction of drilling pads, proper disposal practices, proper well casing and cementing, and recycling of drilling fluids would be in accordance with BLM guidelines and should minimize effects on groundwater quality. If accidental spills occur, they would be addressed through implementation of the Hazardous Materials Management and Release Contingency Plans (appendix C) and Spill Prevention Control and Countermeasures (SPCC) plans developed in accordance with 40 CFR Part 112 (appendix K) for the Atlantic Rim project.

Drinking water sources near the ARPA include a groundwater well field for the town of Rawlins in the upper portion of the Sage Creek watershed, the Little Snake River for the towns of Baggs, Dixon, Savery and Slater, and shallow domestic groundwater wells for rural ranch houses. The loss of hydraulic head in aquifers feeding groundwater sources for domestic wells along the eastern boundary of the project area is the most likely potential impact to these resources; however no domestic water wells are listed in the SEO database along the eastern boundary of the project area. None of the known drinking water sources for municipalities are likely to be impacted from the project. Rawlins city wells located to the east of the Mesaverde Group outcrop and are likely completed in formations below the Steel Shale (a significant aquatard) which underlies the Mesaverde Group. Because only 3 percent of the ARPA is in the Savery drainage upstream of Baggs, Dixon, Savery, and Slater, it is unlikely that the project will impact the quality or quantity of water available for these towns.

Appropriate measures would be taken during project development to prevent impacts on existing groundwater quality during dewatering. Given the present state and federal regulations regarding general water quality, as well as salinity in the Colorado River Basin, surface discharge of produced water is not anticipated. Water would be used during construction,

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

drilling activities, and dust abatement subject to state permits. Most of this water would come from the CBNG wells; however, some may come from sources that could impact surface resources. Therefore, water to be used for construction and dust abatement was estimated and depletions consulted on with the US FWS in regard to the Upper Colorado Endangered Fish Recovery Program. Water produced from coalbeds is assumed to be unconnected to surface water based on isotopic analysis, groundwater modeling and water quality characteristics.

Accidental surface discharge could impact nearby surface water quality by increasing salinity levels. The extent of any impact would depend on the quality and quantity of the produced water and any fluids being released and would be addressed with the implementation of the Hazardous Materials Management and Release Contingency Plans (appendix C).

Water Disposal Using Injection. Produced water would be disposed of in underground injection wells, except in the case of the Cow Creek Pod that has a surface discharge WYPDES permit. The conditions of this permit allow for the same volume of salt and water to be discharged as would have occurred had not well #1X-12 been plugged. Produced water would also be used for drilling, construction, dust abatement, and other project-related water uses subject to approval from the State of Wyoming for this use. Water could also be used in closed-system stockwatering tanks. None of these uses would be for water disposal needs; primary water disposal would be through injection wells.

Underground disposal of produced water would be accomplished using an estimated 166 deep injection wells (appendix K). Depth of the injection wells is expected to range from 3,200 to 6,400 feet (e.g., Hatfield, Cherokee, or Deep Creek sands within the Haystack Mountain Formation). All injection wells would have permits prepared and submitted to the WOGCC. The only effect on the injection formations would consist of an increase in the hydraulic head emanating from the injection well, which would dissipate with distance away from the well bore.

Produced water would be collected in buried polyethylene pipelines for transport to an injection well. Centrifugal pumps, reciprocating pumps, filter systems, and tanks at the disposal facility would be used to remove solids from the water stream and to pump the water at pressures sufficient to allow downhole disposal. In the event that an injection well ceases to operate properly due to formation over-pressuring or mechanical failure, the operator must still remain in compliance with all applicable regulations governing the operation of the produced water disposal system. Compliance options available to the operator include curtailing or halting the rate of water production or routing the discharge to additional injection wells.

Each deep injection well would have an approximate minimum injection capacity of 5,000 barrels per day (bbls/day) and a maximum injection capacity of 15,000 bbls/day. A predicted volume of produced water in the best success scenario from the CBNG wells would be 250,000 to 450,000 bbls/day for approximately 6 to 8 years. The volume of water would consistently decline as the coalbeds are dewatered.

The deep injection wells would be drilled, cased, and cemented from total depth (approximately 50 feet below the base of the Hatfield, Cherokee, or Deep Creek sands) to the surface. These sandstone formations are isolated above by the Lewis Shale and below by the Baxter or Steel Shale, which are thick, competent marine shales that are effective barriers to groundwater flow. The deep sandstones would be tested to evaluate suitability for disposal before any water is injected. Maximum pressure requirements to prevent initiation and propagation of fractures through overlying strata to any zones of fresh water have also been determined and would be

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

regulated by the State of Wyoming and the BLM. The results of the open-hole log and injectivity test would be provided to the regulatory agencies. The injectivity tests would be used to determine the fracture pressure limits that would be imposed to ensure the overlying and underlying shale is not breached. The fracture gradient of the shale aquitards that overlie and underlie the injection horizons would not be exceeded based on injectivity tests and applicable permit limits. Thus, all injected water would be contained in the injection formations and would not migrate vertically.

Groundwater Quality. Well drilling and completion activities are not likely to impact existing groundwater quality if the project is in compliance with On-Shore Oil and Gas Order No. 2. These guidelines specify the following:

...proposed casing and cementing programs shall be conducted as approved to protect or isolate all usable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use.

However, poor drilling and completion techniques could result in degradation of groundwater quality due to the mixing of variable quality waters from different water-bearing strata that happen to be pierced by the borehole. The magnitude of mixing, if any, which would occur during the relatively short period of time during drilling, would be relatively small. In addition, due to the state-of-the-art drilling and well completion techniques, the possibility of degradation of groundwater quality in any aquifers is low.

Usable water is defined as groundwater with a TDS of 10,000 parts per million or less encountered at any depth. To comply with the order, wells must be completed such that either usable water is isolated from unusable water, or that unusable water is isolated from usable water through the use of cementing and other proven technologies. Assuming compliance with this order, no contamination of usable groundwater would likely occur. Well drilling and completion as proposed in chapter 2 appears to comply with the Onshore Order No. 2.

Injection of the CBNG-produced water is not expected to result in any deterioration in groundwater quality within the injection formations. The proposed injection formations have been water quality tested to evaluate suitability for disposal, and the results show that groundwater to be of lower quality (higher TDS) than the produced water from the coalbeds of the Almond Formation. Sandstone strata of the injection formations are isolated above and below by competent shale barriers that would likely prevent the infiltration of the injected water into any overlying fresh water zones. BMPs would be implemented to ensure surface spills of produced water do not occur. All water disposal plans would be permitted with the state agency that regulates the facilities, including but not limited to the WOGCC and WDEQ-WQD.

Springs and Seeps. The ARPA contains numerous springs and seeps which are important local water sources for livestock and wildlife. At least 70 active springs are contained within the ARPA. Prolonged drought in southern Wyoming has reduced the number of seeps, especially in the Sand Hills portion of the project area, but these groundwater resources are expected to recover with cessation of drought conditions.

Springs in the ARPA occur primarily at the contact between the Upper Cretaceous Mesaverde Group and the overlying Tertiary-age deposits of the Browns Park Formation. Springs also

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

occur within the outcrop area of the upper Mesaverde Group itself and at its western contact with the Lewis Shale.

Tertiary deposits in the ARPA near the surface are recharged by direct downward percolation of precipitation and snowmelt. Deep aquifers in the ARPA are recharged by these processes in outcrop and subcrop areas and from slow leakage from overlying and underlying aquifers. The extent of the Tertiary units (Browns Park and North Park Formations) that lie atop the eroded, dipping Cretaceous units indicates a probable recharge of the underlying Mesaverde Group. Should groundwater withdrawals from upper Mesaverde Group coalbeds in the ARPA result in water-level declines that propagate updip to their subcrop areas beneath the overlying Tertiary units, the Proposed Action could affect some of the Cretaceous/Tertiary contact seeps and springs. However, the predicted groundwater drawdown analysis for this project does not indicate groundwater level declines would extend updip to the coal seam subcrop areas. Therefore, it is unlikely that the proposed project would have a dewatering effect on the overlying Tertiary deposits, which would diminish flows from the contact springs and seeps.

Methane seeps could possibly develop in the outcrop region of the Mesaverde Group as a result of this project. These seeps could contaminate shallow groundwater sources and may also cause the death of vegetation in limited areas. The number or location of these seeps is impossible to predict, therefore monitoring would be established to evaluate this impact (See section 4.4.5). These seeps have been documented with CBNG development in the San Juan Basin along with other areas of CBNG development. In the San Juan Basin many of these seeps, even before production, occurred in the outcrop regions of the producing formations.

Groundwater monitoring wells indicate that the reduction of pressure or hydrostatic head within the upper Mesaverde Group will not be isolated to the coalbeds, but will likely extend to Mesaverde sandstones. Artesian conditions in the upper Mesaverde Group may be responsible for the surface expression of springs and seeps located along the Mesaverde and Lewis Shale contact, along faults, or within the Mesaverde Group itself. Impacts may include the loss or reduction of flow in these systems, and would depend on individual spring dynamics. Eventually the upper Mesaverde will recharge with precipitation and pressures will recover. Effected springs and seeps could take 50 years or more to recover. The Lower Mesaverde Group, (Haystack Formation) is the location of the injection zones and therefore could be impacted by increased pressure. Communication of these zones will dictate the feasibility of injection and will be determined by Wyoming injection well permitting.

As described in section 3.4.2.1 although there are numerous perennial springs that occur in the headwaters of Muddy Creek, these springs are not likely adding to the baseflow of Muddy Creek, due to evapotranspiration and conveyance losses. This is evident by the intermittent nature of flows in Muddy Creek. The discharge that makes it to the Little Snake River is primarily from snowmelt or individual precipitation events. Therefore even with loss of flow in springs and seeps, the reduction of pressures in the upper Mesaverde Group is unlikely to result in depletions to the Muddy Creek system.

Flowing Wells. There are at least 16 flowing wells in the project area have been developed to supply water to wetland areas and/or stock watering facilities and may be impacted by reducing flow volumes or changing water quality characteristics. The chemistry of water sampled from at least one of the flowing wells in the ARPA (Duck Flow 2 well, see table 3-29) indicates that the groundwater may be from the Almond Formation coalbeds. Many of these flowing wells are abandoned exploratory oil or gas wells drilled in the 1950s or 60s, that had some portion of the

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

casing fail adjacent to strata under artesian pressure. It is likely that some of these flowing wells have casing failures adjacent to Almond Formation coalbeds (many of the flowing wells produce methane gas along with water, methane is commonly associated with coalbeds). The Almond Formation coalbeds are targeted by this project for production and therefore these flowing wells may be impacted by reduced flow volumes. The groundwater model predicts a 3–30 percent decrease in flowing well volumes by 2050, with full recovery in the year 3000 (WWC 2006). Individual wells may respond very differently depending on the depth and extent of the casing leak or leaks for individual wells.

Water Rights Related to Groundwater. As discussed in chapter 3, the SEO records identify at least 90 active permitted, non-CBNG-associated groundwater rights in the ARPA. Of the 90 permitted wells and springs, 58 reported positive yields, many of these are developed within the Mesaverde Group and/or are associated with the Browns Park Formation. There are also productive wells developed in the Lewis Shale that may be the result of flows from the Mesaverde Group. Groundwater currently in use in the project area that is obtained from Tertiary-age units (i.e. contact springs from sources in the Browns Park Formation) should not be affected by groundwater level declines in the Mesaverde Group coalbeds. However, permitted water rights in the project area that obtain water from the Cretaceous-age coalbeds or other formations in the Mesaverde Group that are dewatered by the proposed project would likely be affected by the resulting groundwater level declines.

A numerical groundwater flow model was used to predict drawdown impacts to the groundwater system under the Proposed Action. Modeling was warranted because of the large extent of, variability in, and cumulative stresses imposed by development of CBNG on the coal bed aquifers of the upper Mesaverde Group. The assumptions used to support the predicted groundwater drawdown analysis, the computer model used in the analysis, and the predicted drawdown impacts for this project are described in detail in the Atlantic Rim EIS Ground-Water Modeling Technical Support Document (WWC 2006).

Regional Groundwater Model Description and Findings

A numerical groundwater flow model was used to predict drawdown impacts to the groundwater system under the Proposed Action. Modeling was necessary because of the large extent of, variability in, and cumulative stresses imposed by development of CBNG on the coal bed aquifers of the upper Mesaverde Group. The assumptions used to support the predicted groundwater drawdown analysis, the computer model used in the analysis, and the predicted drawdown impacts for this project are described in detail in the Atlantic Rim EIS Ground-Water Modeling Technical Support Document (WWC 2006).

The modeling consisted of three separate tasks: calibration and verification, simulation and sensitivity analysis. After a steady state model was calibrated with the goal of matching a known potentiometric surface with modeled results. CBNG wells were then added to the model and calibrated with known pumping rates of CBNG wells. A sensitivity analysis was performed on five modeling parameters: drain conductance, global hydraulic conductivity, hydraulic conductivity within layers 2 and 4, recharge rates, and storage coefficients (WWC 2006).

The regional groundwater flow model for the ARPA is based on the geology and hydrogeology described in chapter 3. The groundwater model encompasses the western flank of the Sierra Madre and extends into the Washakie Basin roughly 30 miles west of the ARPA. This model cannot be used to predict results at a localized scale and any attempts to do so would require

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

additional data and additional modeling efforts. The Atlantic Rim Groundwater Model Technical Report (WWC 2006) includes a detailed discussion on calibration of the groundwater flow model. The hydrogeologic model code selected was the USGS Three Dimensional Finite Difference Modular Groundwater Flow Model, (MODFLOW) (MacDonald and Harbaugh 1988) and the pre/post processor, Groundwater Vistas (Rumbaugh and Rumbaugh 2002).

Hydrogeologic Groups in the ARPA

Within the ARPA, the Mesaverde Group strata dip westward off the Sierra Madre uplift at about 22 degrees. The thickness of the Mesaverde Group ranges from 2,000 to 3,000 ft. The Mesaverde Group consists of four members, which in ascending order are the Haystack Mountains Formation, the Allen Ridge Formation, The Pine Ridge Formation, and the Almond Formation. The uppermost member, the Almond Formation, contains numerous carbonaceous shale intervals and coalbeds. The lateral continuity of these coal units is considered sufficient such that they act as a regional aquifer system. Although individual coalbeds may split and merge, there is sufficient hydraulic communication, on a regional scale, to allow movement of groundwater.

The coal-bearing Almond Formation ranges in thickness from 400 to 600 ft and occurs at depths of less than 100 ft in the center of the ARPA to about 1,800 ft below ground level along the western boundary. The Lewis Shale, which overlies the Almond Formation, reaches a thickness of 2,700 ft in the Washakie Basin and is consistently more than 2,000 ft thick in the ARPA except where it has been removed by erosion. The Lewis Shale is a low permeability unit considered to be a regional confining layer. Unconformably overlying the Cretaceous sediments is the Tertiary-age Browns Park Formation. Contact springs are relatively common at the base of the Browns Park Formation where it is in contact with the less permeable units of the Mesaverde Group. Due to the lack of contact between the Almond Formation and the Browns Park Formation, groundwater within the Browns Park could not be impacted by groundwater withdrawals from the Almond; therefore, the Browns Park Formation was not included in the model.

Assumptions for Groundwater

For the purpose of the modeling study, the primary unit of interest is the coal-bearing Almond Formation and Pine Ridge Formation of the Mesaverde Group. Specifically, the coalbeds within the Almond Formation and the sands in the Pine Ridge Formation are the aquifers of interest. Overlying the Almond Formation is the Lewis Shale, a regional confining layer. Underlying the Almond Formation is the Pine Ridge Formation and beneath the Pine Ridge is the Allen Ridge Formation, which is also considered a confining unit. The Almond Formation and the underlying Pine Ridge Formation are primarily recharged from natural precipitation infiltration along their outcrop on the western flank of the Sierra Madre. The natural groundwater flow direction is generally westward, down dip toward the basin center. Groundwater within the Almond coals is unconfined near outcrop recharge areas, but rapidly becomes confined away from the outcrop. For modeling purposes, the overlying Lewis Shale and underlying Allen Ridge Formation are sufficiently impermeable to prevent leakage into or out of the Almond and Pine Ridge Formations. Infiltration of surface water that occurs in the small ephemeral and intermittent streams in the area can effectively be ignored in the model, as the streams are predominately located within the overlying Lewis Shale. Therefore, little if any recharge can be expected anywhere other than the outcrop area.

A number of flowing wells potentially completed within the Almond Formation are located throughout the ARPA. Potentiometric data, albeit sparse, was compiled for the Almond coals in

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

the ARPA and eastern Washakie Basin. A potentiometric surface map of the Almond Formation under current conditions is included in the Atlantic Rim groundwater model Technical Report (WWC 2006). Hydraulic gradients are steeper near the outcrop and become less steep into the basin. In addition to the potentiometry data, drill stem test data and age-dating Almond coal groundwater indicate that groundwater velocities under natural gradient are extremely low.

The primary physical groundwater flow boundary is the Mesaverde Group outcrop to the east. Near the center of the Washakie Basin, which would be along the western portion of the model domain, evidence suggests that there is little, if any, groundwater flow in the westward direction. Within the model, the western boundary is represented by a no flow boundary. The north and south boundaries are not marked by any natural geologic features, but are located far enough from the proposed production wells in the ARPA that their influence on the wells would be minimal. For this reason, the north and south edges of the model are artificial boundaries.

There is very little measured hydraulic conductivity data available for any of the five modeled layers within the ARPA. The hydraulic conductivities assigned to each layer were based on information that is presented in the Atlantic Rim groundwater model Technical Report (WWC 2006). To account for anisotropic conditions in the vertical direction, the vertical hydraulic conductivity would be 10 times less than the horizontal conductivity. Within the model, the hydraulic conductivity of the sand layers would vary based on the average hydraulic conductivity at burial depth. Like the sands within the Almond Formation, burial depth is assumed to affect hydraulic conductivity for the coals, with a lower value for the deeper coals and a higher value for the shallower coals. Coals would have slightly smaller hydraulic conductivity values than the sand units, but values would be varied with depth similar to the way hydraulic conductivity values for the sand units were varied. At this time, there is very little reliable storativity or specific yield data for the modeled layers; therefore, values were based on USGS estimates, which are based on the estimated thickness of the aquifers (WWC 2006).

The groundwater model necessarily simplifies the geology that is apparent in the Upper Mesaverde Group. For example, there are three monitoring wells in the ARPA that were established during the interim drilling period and will be maintained through the life of the project. These monitoring wells measure pressure in the producing coalbeds and sand stone aquifers directly above and below the coalbeds. Groundwater monitoring data appears to confirm that the coalbeds and sand layers in the upper Mesaverde Group are hydrologically connected. Locally, the hydraulic connection between the coal layers and sand layers could potentially be enhanced if the integrity of the confining layer is compromised (e.g., by poorly plugged exploratory drill holes). Leakage from the sands into the coal production layer appears to be occurring as water levels in the coalbeds are lowered as a result of dewatering. It is likely that many of the coalbeds are in juxtaposition with overlying and/or underlying sandstones, because much of this area is faulted. This means that the coalbeds within the upper Mesaverde Group are not isolated from sands in the Upper Mesaverde Group. There is hydrologic connection predicted between layers 1, 3 and 5; therefore the model construction allows for this complexity to some degree, but can not model the spatial variability in transmissivity between layers that most likely exists.

Model Construction

The hydrogeologic model code selected was the USGS Three Dimensional Finite Difference Modular Groundwater Flow Model, MODFLOW (MacDonald and Harbaugh 1988) and the pre/post processor, Groundwater Vistas (Rumbaugh and Rumbaugh 2002). MODFLOW is a

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

model code widely used and accepted by regulatory agencies and the BLM. Seven MODFLOW packages were used in the Atlantic Rim groundwater model (WWC 2006).

The model grid is oriented parallel to the geologic strike of the Almond Formation outcrop, which is generally north-south. The model area encompasses some 2,866 square miles. The regional model consists of five layers. The top layer represents the Almond Formation sandstones, the second layer represents the clay and siltstone parting below the Almond sandstones, the third layer represents the production coalbeds within the Almond and Pine Ridge Formations, the fourth layer represents the clay and shale partings below the coalbeds, and the fifth layer represents the Pine Ridge Formation. As mentioned above, the monitoring wells indicate that there may be more hydraulic communication than represented by the model, between the producing formations and the upper Almond and Pine Ridge sandstones, modeled by layers 1 and 5. The Lewis Shale acts as a confining layer above the Almond Formation and the Steel Shale acts as a confining layer below the Pine Ridge Formation. The model area is bounded on the east by the outcrop of the Almond Formation, on the west by a no-flow boundary, and due to the lack of natural geologic boundaries, prescribed constant head cells bound the north and south portions of the model domain.

The hydraulic parameters within the groundwater model area include hydraulic conductivity, storage, and recharge. Hydraulic conductivity is largely unknown in the model area and values assigned within the model were based largely on information obtained from testing conducted in oil and gas fields outside of the model area by the oil and gas industry, limited testing on coals within the ARPA, and testing of coals within the Powder River Basin in Wyoming. Based on borehole logs within the ARPA, the bulk of the Almond Formation and Pine Ridge Formation is generally composed of sand, with the coals, siltstones, and shales making up a small portion of the formations. Within the model, the hydraulic conductivity of the sand layers would vary based on the burial depth (i.e., values decrease with depth). The hydraulic conductivity values assigned to the shales and siltstones were much lower than that of the sands and coals. Storage coefficients within the model were estimated based on the modeled thickness of each layer. Due to instabilities in the model based on the steep (22 degree) dip of the Mesaverde group, some of the modeled thicknesses do not correspond to actual thicknesses of formations. This decision is unlikely to impact the results of the model. To account for anisotropic conditions in the vertical direction, the vertical hydraulic conductivity was estimated to be 10 times less than the horizontal conductivity ($K_y = K_x = 10K_z$).

The principle source of recharge is natural precipitation infiltration at the Mesaverde Group outcrop on the western flank of the Sierra Madre. Within the model, recharge would occur within the upper portion of the Mesaverde Group containing the Almond Formation and Pine Ridge Formation and the total recharge would be 3–9 percent of the average annual precipitation.

Groundwater flow into the Washakie Basin is very sluggish, if it even occurs at all. Based on this assumption, it follows that there are no natural drains within the interior portion of the basin. The only natural drains to the system occur near the contact between the upper Mesaverde Group and the overlying Lewis Shale as springs. These contact springs were simulated in the model as drains inserted into the top layer. The only other drains within the model area are flowing wells completed in the Almond Formation. The flowing wells are discharging from the same coalbeds that are proposed to be produced; therefore, they were inserted into layer 3. The locations and elevations of the springs and flowing wells were determined from U.S.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Geological Survey mapping and Wyoming SEO records. Spring discharge rates were also determined from SEO records or assumed to be similar to that of nearby measured spring flows.

Limitations of the Model

Many of the assumptions and limitations within the modeling software are the result of the inaccuracies inherent in modeling a natural system and are generally similar for all modeling software. Limitations and assumptions specific to this modeling effort are primarily due to the paucity of physical and hydraulic characteristics of the aquifers and confining units in the regional model area, as described in detail in the Atlantic Rim groundwater model Technical Report (WWC 2006).

Simulation of the Projected Effects

The simulation portion of the model replicates the proposed development within the ARPA. Presently, the most severe development scenario projects that a maximum of 1,800 CBNG wells would be completed within the ARPA. Current production predictions estimate that the wells would produce water for 20 to 30 years, so the average life of water production for each well was 25 years and each drain simulating a well was left active for 25 years within the model. The development scenario assumes that wells within the interior portion of each unit would be developed first, with wells expanding concentrically from the center of the unit out to the edges of the ARPA boundary. After a drain was turned on, it was left on for 25 years. The modeled simulation period extends in 5-year increments from 2005 to 2050, with the last production well being turned off in 2050. Drawdown contours from the projections within the five modeled layers at the end of each 5-year period are shown in figures included in the Atlantic Rim Groundwater Model Technical Report (WWC 2006).

The results of the simulation show that the drawdowns within the coalbeds (layer 3) are large as compared to the drawdowns projected within the overlying and underlying sands (layers 1 and 5, respectively). The maximum drawdown and areal extent of drawdown within the Almond Formation coal (layer 3) is projected to occur in 2030. Drawdown contours projected to occur for layers 3 (coal package), 1 (overlying sandstone package), and 5 (underlying sandstone package), respectively, in year 2030 are depicted on maps M-35, M-36, and M-37. As shown, maximum cumulative drawdowns in the coal are greatest at the production well locations, although drawdowns do not propagate down dip to the west. In fact, no drawdowns in the produced coal are expected to occur beyond the western boundary of the ARPA. Coal drawdowns are projected to propagate somewhat more in the updip direction toward the Almond Formation's outcrop, although would not actually reach the outcrop. Based on the monitoring well data these impacts to layers 1 and 5 may be more significant than predicted by the model.

While the drawdowns within the coalbeds are large close to the producing wells, the water discharge rate decline for each well is not as rapid as expected. Table 4-6 presents the average per well discharge rate at the end of each 5-year period between 2010 and 2050. Table 4-7 depicts the modeled impacts to the various existing flowing wells within the ARPA, and as shown, impacts to the flowing wells are predicted to be minimal. Impacts to the contact springs are also predicted to be minimal. In year 2005, the modeled spring discharge was approximately 88,800 cubic feet per day for the entire model area. In year 2050, the modeled spring discharge was approximately 85,700 cubic feet per day for the entire model area.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Table 4-6. Average per Well Discharge Rates in Five-Year Increments during the Simulation Period.

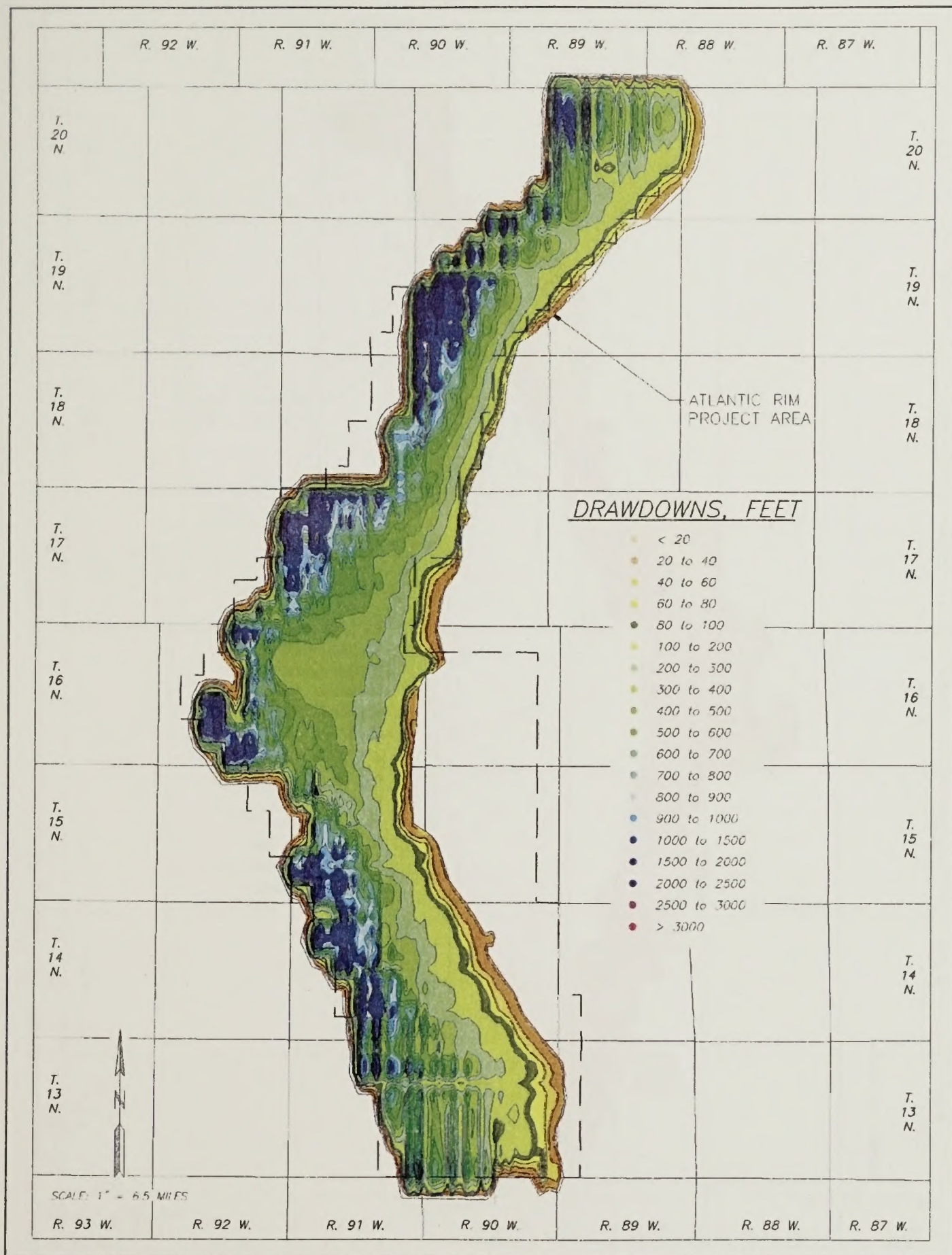
Year	Number of Wells in Production	Average Discharge Per Well (gpm)
2005	48	30.1
2010	989	32.4
2015	1368	34.2
2020	1651	33.7
2025	1720	32.9
2030	1682	32.9
2035	904	34.4
2040	422	33
2045	105	22.9
2050	8	7.8

Table 4-7. Impacts to Flowing Wells in Year 2050.

Latitude	Longitude	Row	Column	Year 2000 Modeled Flow Rate (gpm)	Year 2050 Modeled Flow Rate (gpm)
41.0894	107.4968	114	190	30	27.9
41.0725	107.5053	115	188	28	26
41.0887	107.4782	114	195	2	1.4
41.1985	107.5103	95	186	15	12.9
41.2613	107.5798	84	167	2	1.6
41.6022	107.4658	22	199	3	2.2
41.2263	107.5572	90	173	21	20.4
41.1946	107.5880	96	165	5	3.5
41.1902	107.5675	97	171	5	4.0
41.3024	107.6040	76	161	21	19
41.3240	107.6160	73	157	9	8
41.3493	107.6245	68	155	24	21.4
41.3495	107.5956	68	163	8	7.2
41.3815	107.5660	62	171	9	8.6

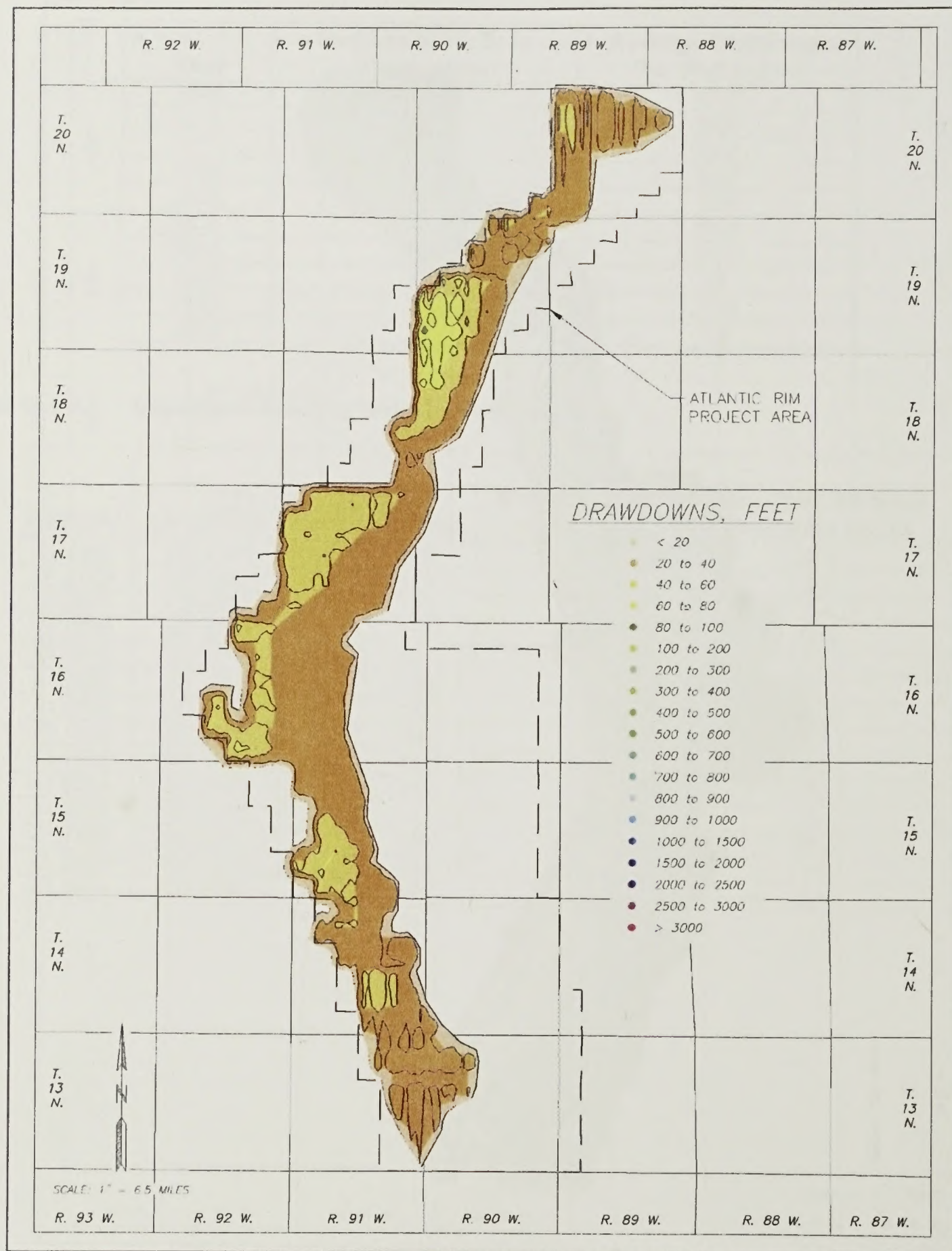
Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-35. Drawdowns within Layer 3 for Year 2030.



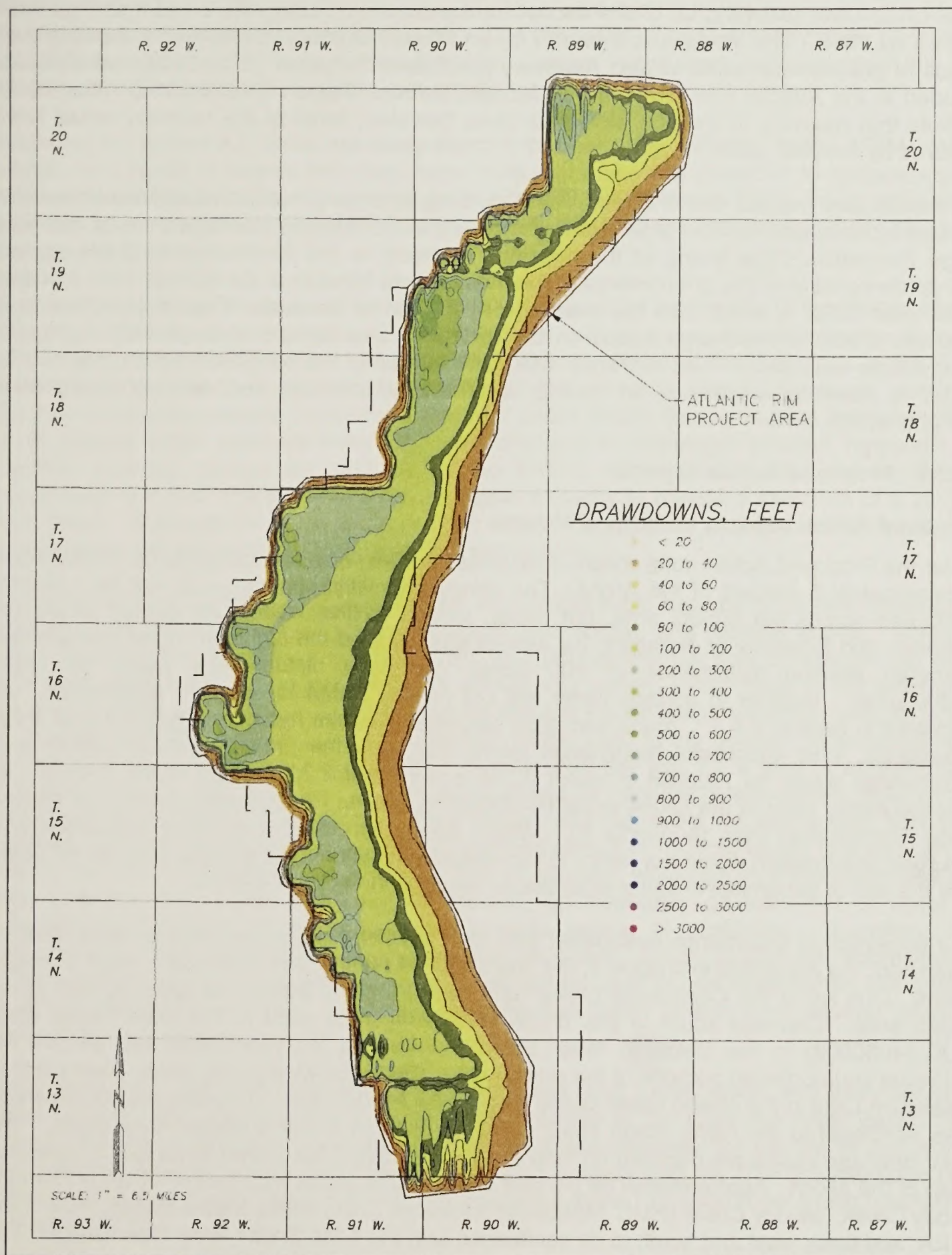
Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-36. Drawdowns within Layer 1 for Year 2030.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-37. Drawdowns within Layer 5 for Year 2030.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

After water production starts to decline, recovery of water levels in the coals will begin. Based on the projected schedule of field development, all production is expected to end by 2050. In order to simulate recovery, all drains except for the ones simulating the contact springs were shut off by 2050. The model was then run for an additional 950 years to model the long-term effects of groundwater withdrawals. Recovery predictions for years 2100, 2500, and 3000 are included in the Atlantic Rim Groundwater Model Technical Report (WWC 2006). The model predicts that recovery in the coal would be slow; however, most of the recovery would have occurred by the year 3000.

The model also predicts that it takes a relatively long time for groundwater adjustments within the coal to have an effect on groundwater levels within the Almond Formation sands and Pine Ridge Formation. The timing of the maximum impacts to the Almond/Lewis Shale contact springs demonstrates this phenomenon. The most severe impacts to the springs were modeled in the year 3000, at which time the discharge rates start to increase. This recovery scenario assumes a constant recharge based on the recharge rates arrived at empirically during the steady-state calibration. This recharge rate, while arguably the best assumption that can be made, is nevertheless based on limited calibration experience and research information available at this time.

4.4.3.2 Proposed Action Impacts

Proposed Action Impacts to Surface Waters

Under the Proposed Action, total construction phase surface disturbance would be 15,800 acres (approximately 6 percent of the ARPA). The construction disturbance would not be uniformly distributed across the project area, but rather, project facilities would be located where the efficiency and feasibility of extracting the natural gas would be the highest. Combined with the estimated existing disturbance of 600 acres, cumulative disturbance would be about 16,400 acres. Impacts to surface water are not directly related to surface disturbance. As described in section 4.4.3.1, roads and pads can impact surface hydrology beyond their initial disturbance. With successful reclamation during the life of the project (30–50 years), total disturbances would be reduced to about 6,200 acres (about 2.3 percent of the ARPA). As describe earlier most of the ARPA would be difficult to reclaim. Reclamation success is defined in the Reclamation Plan (appendix B). Where sagebrush, juniper or other vegetation was disturbed, the location would not return to pre-disturbance hydrologic function until 30–50 years after the end of the project in some locations as described in section 4.4.3.1.

The construction disturbance associated with the Proposed Action can also be distributed by watershed. As discussed in chapter 3, the entire ARPA is contained within three major drainage basins. One leg of the Continental Divide runs east and west across the upper portion of the project area. Drainage south of this divide flows south and west to the Little Snake River (HUC 14050003) in the Colorado River Basin. A second leg runs north and divides the northwest and northeast portions of the project area. Drainage west of this divide flows north to Separation Lake in the closed Great Divide Basin (HUC 14040200). Drainage east of the divide flows northeast to the North Platte River (HUC 10180002) in the Missouri River basin. The major drainage basins are depicted on map M-14. The Little Snake River flows east to west just south of the ARPA. Approximately 69 percent of the ARPA drains into the Little Snake River via Muddy Creek. Muddy Creek (HUC 14050004) originates in the Sierra Madre Range, east of the ARPA, and flows west and south to its confluence with the Little Snake River near Baggs. The primary Muddy Creek tributaries in the ARPA include, from upstream to downstream, McKinney Creek, Dry Cow Creek, Cow Creek, Wild Cow Creek, Cherokee Creek, and Deep Creek.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Increasing sediment delivery to watersheds above the 303d section of Muddy Creek (section 3.4) would lead to habitat degradation in pools and riffles for fish in these waters, resulting in significant effects. The primary watershed contributing to this segment is the Muddy Creek/Alamosa Gulch watershed (map M-10). The Proposed Action with eight wells per section in this watershed would lead to increases in surface runoff and sedimentation into this watershed and would result in significant impacts.

According to chapter 3.3, there are many topsoils that are saline or sodic in the ARPA. When eroded as a result of project activities, these soils can make salt available to surface waters. This would contribute to the non-point source of salt in the Colorado River Basin and can be expected to be a significant impact to this system because these rates would likely be above background conditions.

Many of the drainage channels in the ARPA may be classified as Waters of the United States. Crossings of these channels and any associated wetlands may require authorization from the ACOE through the CWA Section 404 permitting process. None of the drainages in the Great Divide Basin are likely to be considered Waters of the United States. Because, road and pipeline construction across established channels could modify flow hydraulics, required BMPs would protect these channels from long-term changes in hydrologic function (appendix H). Channel crossing design (as outlined in the BMPs) will minimize changes to channel morphology and flow hydraulics and have suitable capacity to handle a minimum of a 25-year flood event. Guidance for designing crossings is given in appendix J; these would be required for drainages with the potential to support fish populations.

As described in appendix K, water would be required in most aspects of project construction including road construction, drill site construction, well drilling, and pipeline testing. Water for use in the project construction could be as high as 1,000 gallons per acre of disturbance, which would equate to a total of approximately 54 acre-feet of water. Water used in the well-drilling process could be as high as 125,400 gallons, or about 0.4 acre-feet of water per well, for a total of approximately 693 acre-feet (for 1,800 wells). Water used in the deeper, conventional well-drilling process averages 462,000 gallons (1.4 acre-feet) per well for a total of approximately 280 acre-feet (for 200 wells). The operators intend to use freshwater-based mud for the majority of their drilling operations. Water would also be used for hydrostatic testing of pipelines. Assuming one set of pipelines per well pad (single or multiple wells), and all pipelines associated with 2,000 well pads (7,920,000 feet of pipeline) would be hydrostatically tested at once and therefore water would not be reused, approximately 64 acre-feet of water (at 2.6 gallons/feet) would be required for hydrostatic testing of pipelines. Therefore, total water demand with hydrostatic testing for the Proposed Action would be approximately 1,100 acre-feet. This total quantity of water would not be used at one time; rather, this amount would be distributed over the construction phase that could extend over several years as discussed in appendix K.

Water used for construction and drilling may not come from CBNG wells, and therefore could possibly come from sources connected to surface waters in the Colorado River Basin. This volume of water is conservatively estimated as 10.3 acre-feet/year for the life of the project. The potential depletions were part of the consultation process with the USFWS and have been considered in regard with native fish recovery programs in the Colorado River Basin (section 4.8 and appendix G).

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Water would be obtained from SEO-approved local surface water sources or water wells completed in the coalbeds of the Mesaverde Group. As described in chapter 3, there are presently 90 active permitted groundwater rights filed in the project area, one of which is for a water well that supplies water for drilling deep oil and gas wells. Historically, water wells have been the primary source of supply for oil and gas drilling in this arid area; it is likely that water wells would supply the proposed project drilling needs. The total water demand identified above would not likely affect the existing surface water or groundwater rights in the project area administered by the Wyoming SEO.

Reclamation would occur on the barrow ditches for roads, portions of well pads, and pipeline ROWs, as described in appendix B. Even after successful reclamation these areas would form distinct vegetation boundaries that may or may not be better for reducing rain-splash erosion or decreasing surface runoff. They also may experience unauthorized travel from off-road vehicles leading to further erosional problems.

Discharge and use of hydrostatic test water would need to be accomplished in a manner that does not affect soils, stream channels, surface water, and groundwater quality. After testing operations are completed, the water would be pumped into water-hauling trucks and transported to drilling locations within the project area to be used in conjunction with drilling operations or reused for other aspects of the construction and production process. However, if such water is not reused, it must be disposed of in a manner where soil scouring and water quality impairment would not result. Hydrostatic test water is expected to be of relatively good quality; however, it should be evaluated for compliance with state water quality standards. No test water should be discharged unless such water meets these standards. Test water not needed for drilling operations that meets water quality standards would be disposed of onto undisturbed land having vegetative cover or into an established drainage channel in a manner as not to cause accelerated erosion. Further, use and disposal of hydrostatic test water must comply with the mandatory ROW stipulation for hydrostatic testing as well as the POD, the CWA and the WYPDES permit that would be required for the proposed project.

Proposed Action Impacts to Groundwater

The proposed CBNG development in the ARPA is targeted principally at coalbeds in the Almond Formation member of the late Cretaceous Mesaverde Group. Drilling depths for the Mesaverde coals would range from approximately 1,200 to 6,000 feet. Groundwater would be removed from the coal bed aquifers. There is no current practical use for water in these coalbeds due to the high TDS concentrations, and the availability of higher quality water from other aquifers. The targeted coal bed aquifers that would be dewatered are classified as confined to semi-confined aquifers because they are bound by confining sedimentary layers of shale, siltstone, and claystone that are impervious to semi-pervious.

Effects from the development of CBNG to groundwater resources within and near the ARPA have also been evaluated in the South Baggs Area Natural Gas Development Project EIS (USDI-BLM 2000b), the Rawlins Draft RMP DEIS (USDI-BLM 2004c), and the following environmental assessments: Sun Dog Pod (USDI-BLM 2001b), Blue Sky Pod (USDI-BLM 2002b), Cow Creek Pod (USDI-BLM 2002c), Brown Cow Pod (USDI-BLM 2003d), Doty Mountain Pod (USDI-BLM 2003e), Red Rim Pod (USDI-BLM 2003f), Jolly Roger Pod (USDI-BLM 2004b).

Reserve pits would be used to contain drilling fluids, cuttings, and wastewater produced from the well drilling operations. In some cases, the reserve pits would be lined with an impermeable

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

liner to prevent seepage and possible contamination of surface and groundwater. Leakage of pit fluids would be minimal from lined reserve pits unless the liners were installed incorrectly or the liners were damaged during drilling operations.

4.4.3.3 Alternative A (No Action)

Under Alternative A, the impacts would not be significant because the Proposed Action or other action alternatives would not be implemented. For both ground and surface waters, impacts would continue as described in the environmental assessments developed for each pod during the interim drilling period. It can be expected that, as interim reclamation success improves, impacts to surface water resources would decrease. Final reclamation would disturb areas again initially, but long-term reclamation would reduce impacts to background levels within 30–50 years after final reclamation.

4.4.3.4 Alternative C

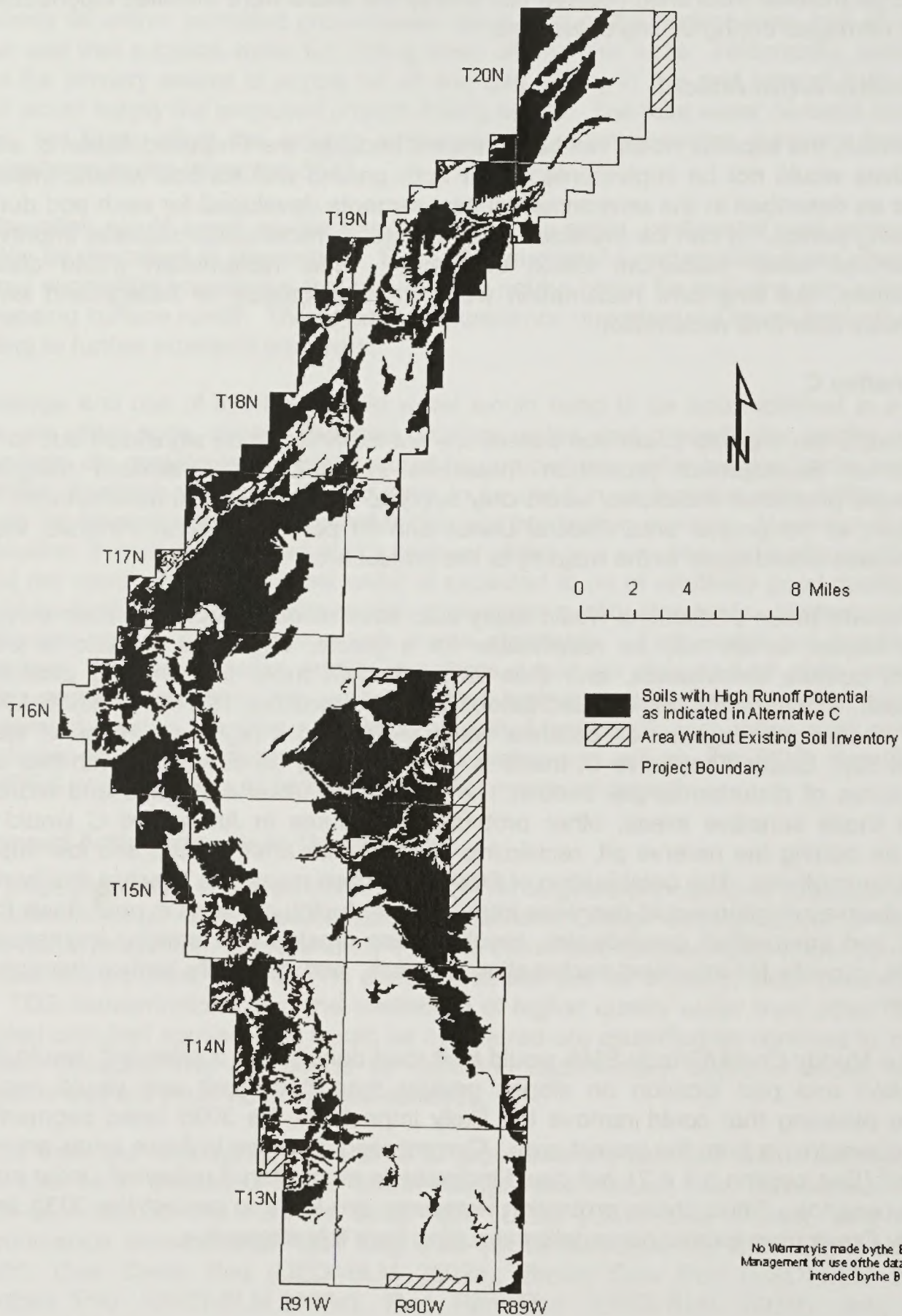
Under Alternative C the impacts to surface waters are not expected to be significant due to the implementation of development protection measures in addition to standard mitigation measures. These protection measures would only apply to Federal Mineral development, but with 64.3 percent of the project area Federal Lands and 66 percent Federal Minerals, these protection measures would apply to the majority of the project area.

The locations where these protections would apply also have unique conditions, such as poor soils or steep slopes, which may be responsible for a greater degree of impacts to water resources from surface disturbance, and thus would benefit more from having protection measures applied. For example, the blocked federal land in Townships 15N 90W and 16N 90W (map M-3) have soils with high runoff potential (map M-38) and a high percentage of steep slopes (map M-39). Under Alternative C, these areas would only be developed with four well sites and 20 acres of disturbance per section. In addition to fewer well sites and reduced disturbance in these sensitive areas, other protection measures in Alternative C would be applied, such as closing the reserve pit, reclaiming the first year after drilling, and low impact road design, among others. The combination of these protection measures in areas that benefit the most from their application would decrease impacts by reducing changes in peak flows from surface runoff and intercepted groundwater, result in less erosion and smaller increases in sediment loads, provide for improved reclamation success, and generally reduce impacts to water resources.

Mitigation in the Muddy Creek/Grizzly SMA would limit road densities to 3 miles/mi², would limit road construction and pad location on slopes greater than 8 percent and would require comprehensive planning that could remove the likely impacts to the 303d listed segment of Muddy Creek downstream from the project area. Current road densities in these areas are less than 2 miles/mi² (See section 3.4.4.2), but could increase to more than 3 miles/mi² under some development scenarios. Thus, these protection measures are likely to protect the 303d listed reach of Muddy Creek from habitat degradation resulting from this alternative.

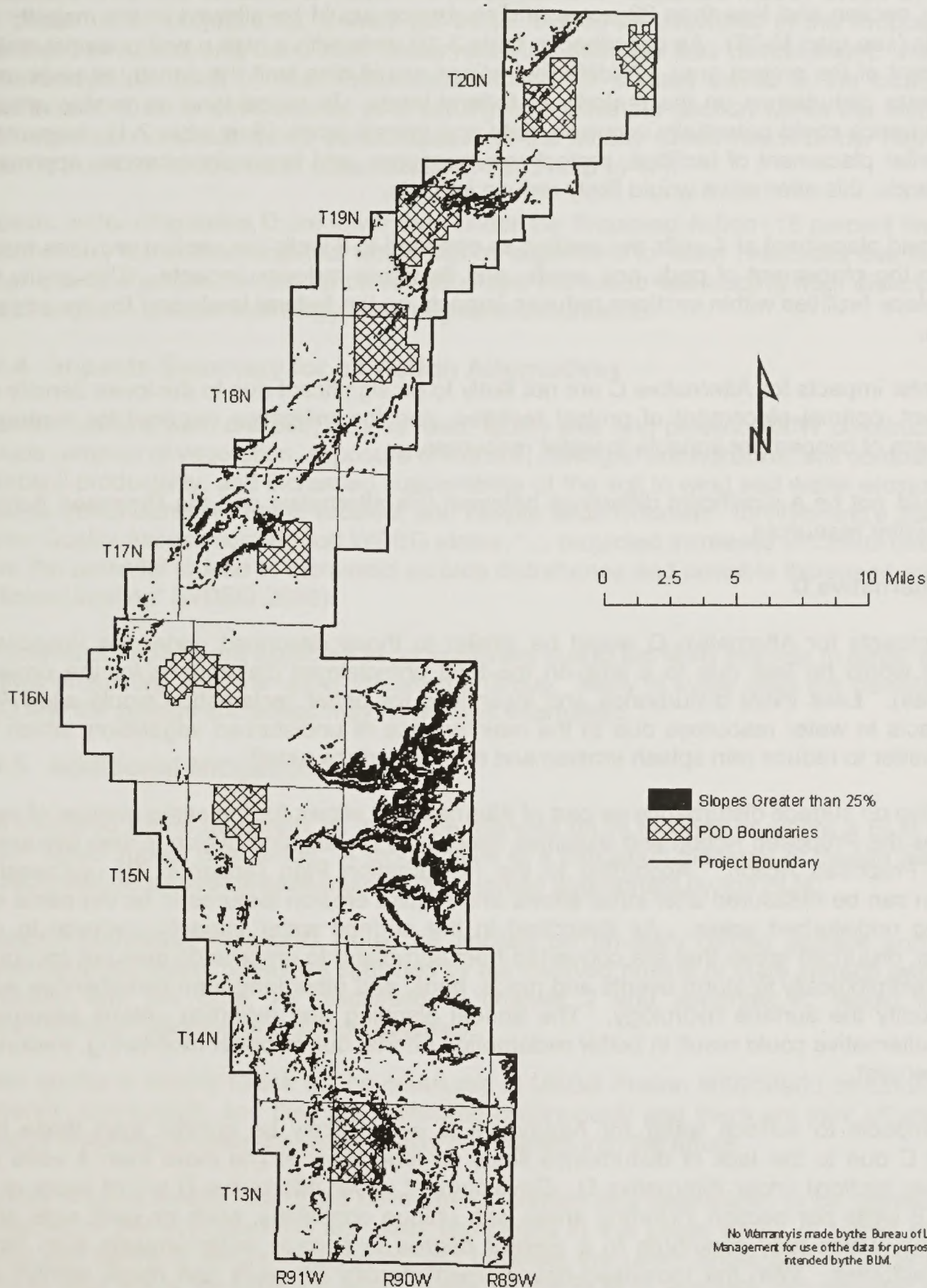
Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-38. Soils with High Runoff Potential.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-39. Alternative C—Slopes Greater than 25%.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

In general, development protection measures proposed for Alternative C would have the effect of limiting surface disturbance in the areas of most concern for impacts to surface waters. Only 4 wells per section and less than 20 acres of disturbance would be allowed in the majority of public lands (see map M-38). As described in table 3-10, soils with a high runoff potential make up 41 percent of the project area. Wildlife restrictions would also limit the density of pads and the short-term disturbance on the majority of federal lands. In mixed land ownership areas, more disturbance could potentially occur on state and private lands (See table 2-1). However, with the better placement of facilities, protections measures, and fewer disturbances approved on public lands, this alternative would likely reduce impacts.

Road and pad placement at 4 wells per section as opposed to 8 wells per section provides more flexibility in the placement of pads and roads, and therefore reduces impacts. This ability to optimally place facilities within sections reduces impacts on the federal lands and for the project as a whole.

Surface water impacts for Alternative C are not likely to be significant due to the lower density of development, optimal placement of project facilities, and the mitigation required for resource areas that are of concern for impacts to water resources.

There should not be a significant difference between this alternative and the Proposed Action for groundwater resources.

4.4.3.5 Alternative D

Potential impacts for Alternative D would be similar to those described under the Proposed Action, but would be less due to a limit on the total unreclaimed disturbance for the project (7,600 acres). Less initial disturbance and incentives for better reclamation would allow for fewer impacts to water resources due to the maintenance of undisturbed vegetation, which is generally better to reduce rain splash erosion and reduce surface runoff.

The limitation on surface disturbance as part of Alternative D allows for the same number of pad locations as the Proposed Action and assumes successful reclamation, which is also assumed under the Proposed Action. According to the Reclamation Plan (appendix B), successful reclamation can be measured after initial efforts and require erosion features to be the same as surrounding undisturbed areas. As described in the surface water impacts common to all alternatives, disturbed areas that are converted from shrubland to grasslands may not respond the same hydrologically to storm events and roads, pads, and other long-term disturbances and will still modify the surface hydrology. The annual planning and reporting criteria assumed under this alternative could result in better reclamation efforts, due to better monitoring, tracking, and enforcement.

Potential impacts to surface water for Alternative D would likely be greater than those for Alternative C due to the lack of disturbance limits on federal lands (no more than 4 wells or 20 acres per section) under Alternative D. Development under Alternative D would occur at a density of 8 wells per section including areas with unique conditions, such as poor soils and steep slopes, which may contribute to a greater degree to surface water impacts from land disturbing activities. With the increased development density for wells and roads relative to Alternative C, Alternative D would be expected to result in a greater impact to surface water despite the limitation on unreclaimed surface disturbance.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Disturbance to Category A (map M-7, 72,200 acres or 27 percent of the ARPA) areas for this alternative would be reduced to below 6.5 acres per well. Because Muddy Creek SMA is near the center of the project area, it likely will be developed as described in the Proposed Action with the Cow Creek and Sand Hills SMAs receiving relatively less development. As stated in the assumptions much of what determines impacts for surface waters is the location of the disturbance. Due to development at a density of 8 wells per section within the Muddy Creek SMA significant impacts would be anticipated to the Muddy Creek reach below Highway 789, which is listed for 303d threats (See section 3.4 and map M-17).

Impacts under Alternative D are lower than under the Proposed Action (18 percent less surface disturbance), but indirect impacts would still be significant to water resources due to potential water quality changes, rainfall runoff relationships, increased salt loading from disturbed areas, and changes in surface hydrology from long-term disturbance.

4.4.4 Impacts Summary for all Action Alternatives

Impacts resulting from drill pad, access road, facility site, and pipeline ROW construction could include removal of vegetation, exposure of the soil, mixing of soil horizons, soil compaction, loss of topsoil productivity, and increased susceptibility of the soil to wind and water erosion. These impacts could increase runoff, erosion, and off-site sedimentation. In Wyoming's 2006 305(b) Water Quality Assessment Report WDEQ states, "... projected increases in CBNG development have the potential to lead to increased surface disturbance and possible increased erosion and sediment loading" (WDEQ 2006).

Groundwater impacts are expected to be significant due to the likely impacts to wells, seeps and springs emanating from the upper Mesaverde Group. Many of these wells are permitted by the SEO and the springs and seeps may have flows interrupted.

4.4.5 Additional Mitigation Measures

The Required BMPs (appendix H) would be followed on BLM lands or where a BLM approved action would impact BLM lands. A modification to a mitigation measure or design feature may be approved on a case-by-case basis when deemed appropriate by the BLM.

Applicant committed measures would be applied on privately owned surface and State of Wyoming lands unless otherwise specified by the involved private or state surface owners. The operators and the BLM, as discussed in chapter 2 and appendix K, would implement preconstruction planning and design activities.

Water quality in Muddy Creek will be measured at USGS Station #09258980 as funding allows. Currently, conductivity and flow are measured continuously and there are joint efforts with the State of Wyoming to measure water quality parameters into the future.

Impacts to groundwater resources have been identified and determined to be significant. The resources of primary concerns are wells completed in the Lewis Shale or upper Mesaverde Group and spring or seeps near the contact between the Lewis Shale and Mesaverde Group. Isotopic data would be collected project wide by the BLM to evaluate groundwater resources and additional monitoring wells in the upper Mesaverde Group would be established to evaluate and quantify impacts to these resources and to quantify potential impacts from methane seeps where the Mesaverde Group outcrops.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

A Local Meteoric Water Line (LMWL) would be established based on BLM collected isotopic water samples from surface sources to test assumptions in section 3.4.5.2 about the recharge characteristics of water in coal beds targeted for production base on isotopic analysis of samples from the producing formations.

The BLM would evaluate water levels from a few selected wells to establish baseline conditions in aquifers of interest and to measure potential impacts from the project.

4.5 Vegetation and Wetlands

4.5.1 Introduction

Direct impacts to existing native shrub/grassland communities in the ARPA resulting from project implementation include a short-term reduction of herbaceous vegetation and a long-term loss of shrub cover. Potential indirect impacts to the vegetation resource may occur as a result of:

- Damage to biological soil crusts,
- Soil compaction,
- Mixing of soil horizons,
- Loss of topsoil productivity,
- Increased soil surface exposure,
- Soil loss due to wind and water erosion,
- Increased potential for noxious/invasive weed invasion and establishment,
- Shifts in use patterns or amounts by livestock and wildlife, and
- Changes in visual aesthetics.

4.5.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with vegetation and wetland resources:

- To provide habitat quality (food, cover, space, and water) adequate (1) to support a natural diversity of wildlife and fisheries including big game; upland game; waterfowl; non-game species; game fish; sensitive, threatened, and endangered species; and species of special management interest in Wyoming, and (2) to assist in meeting goals of recovery plans.
- To maintain or improve vegetation condition or avoid long-term disturbance in high priority standard habitat sites and fisheries areas.
- To maintain or improve overall ecological quality, thus providing good wildlife habitat, within the constraints of multiple-use management in moderate and low priority standard habitat sites.

Several criteria were used to determine the significance of impacts caused by the construction and operation of the proposed natural gas project on vegetation resources encompassed within the ARPA. These criteria were developed based on federal, state, and local agency rules, regulations, and management guidelines.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

The impact on vegetation would be considered significant if the following were to occur:

1. Non-attainment of short- or long-term reclamation standards and goals for disturbed sites specified by the Reclamation Plan (appendix B) or the BLM resulting in a loss/decrease of plant species density, diversity, and abundance, or where reclaimed areas do not attain adequate vegetation groundcover and species composition to stabilize the site within 5 years from disturbance;
2. An event or action that would remove a community's unique attributes or ability to support other resource values within the life of the project; and
3. Introduction or spread of noxious or invasive weeds that contributes to unsuccessful revegetation, the introduction of weeds into areas considered weed free, or an increase in noxious or invasive species where they already exist.

4.5.3 Direct and Indirect Impacts

4.5.3.1 Direct and Indirect Impacts Common to All Alternatives

Direct impacts include the removal of native vegetation and topsoil during the construction phase and installation of permanent structures (e.g., compressor sites, roads, and well pads). Future climatic patterns, land use, and compliance with the Reclamation Plan and weed control efforts would be primary factors for successful life-of-project reclamation. Established monitoring sites for documenting long-term trends of vegetation cover types would be avoided so that disturbance from permitted commercial activities would not occur.

Potential indirect impacts to the vegetation resource might occur as a result of:

- Soil compaction,
- Mixing of soil horizons,
- Loss of topsoil productivity,
- Increased soil surface exposure causing increased soil loss due to wind and water erosion, and
- Increased potential for noxious/invasive plant establishment.

Additional indirect impacts occur as a result of altered runoff hydrology due to roads, pads, and other facilities particularly on moderate to steep slopes. Slopes greater than 8 percent require special engineering and are found on 35 percent of the project area. Facilities located in these areas reduce natural runoff to downslope locations and increase channelization of flows and gullying, which results in desertification effects including lower productivity, cover, and species composition. Furthermore, dust from roads contributes to an additional indirect impact by settling on nearby vegetation resulting in reduced photosynthetic activity and plant growth. Indirect impacts due to dust from roads would be expected to affect vegetation adjacent to roads, resulting in an additional 15 to 30 percent of the development area (based on estimate of 300 feet width impacted along roads average distance impacted based on professional

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

judgment). However, application of BMPs in road construction and dust control would minimize this impact (appendix K, section K.1.3.7.2, specifically, Climate and Air Quality).

All alternatives would disturb Wyoming big sagebrush and alkali sagebrush plant communities. Due to the very long to unknown recovery rates for these two shrub species on dry, harsh sites, reclamation would primarily result in herbaceous plant recovery, replacing shrublands with grassland-type cover and structure.

The saltbush steppe vegetation cover type would have very low acreage affected by the proposed project. Badlands have sparse vegetation, occur on moderate to steep slopes, and are common in other areas. Therefore, impacts from disturbance to these vegetation cover types would not affect their overall abundance, health, or diversity across the region.

Thirty-one percent of the aspen, juniper woodland, serviceberry, and true mountain mahogany cover types occur on private and state lands and these sites would not be protected from disturbance by any development. Loss of these communities would increase wildlife use on remaining areas within these cover types. Development in these communities would be avoided on public lands. However, impacts from disturbance to this vegetation cover type may affect its overall abundance, health, and diversity within the region, exceeding the significance criteria.

The silver sagebrush/bitterbrush vegetation cover type occupies sand dunes in what is known as the Sand Hills. The uniqueness of this vegetation/soils complex within the entire State of Wyoming led to the designation of the Sand Hills as an ACEC. The actual ACEC is mostly excluded from the ARPA, but the north end of this unique plant community is in the checkerboard land pattern (map M-3) and a portion is included in the ARPA. The sand dunes, whether stabilized or not, are usually avoided due to the difficulties they pose for development and reclamation. The potential to increase wind erosion and destabilize the loose sand is very high. Therefore, impacts from disturbance to this vegetation cover type may affect its overall abundance, health, and diversity within the region, exceeding the significance criteria.

Due to the scarcity of riparian/wetlands in the ARPA and the existence of BMPs/COAs to protect them, the probability of well pads, roads, pipelines, and ancillary facilities being placed in these areas is very low. The RMP specifies that a 500-foot (minimum) buffer around riparian and other water resources and a 100-foot buffer from ephemeral drainages be maintained on public lands. This restriction not only protects riparian/wetland sites, but basin big sagebrush sites which are generally found adjacent to drainages. Protection of these sites on private and state lands may not occur, which could lead to alteration of vegetation adjacent to stream channels. The probability of removing wetland vegetation or disturbing any waters of the U.S. is low following compliance with mitigation procedures (see appendices B, H, and J). Existing water sources that dry up or have reduced flows due to water drawdown associated with gas field development would be mitigated to maintain wetlands/riparian site characteristics and vegetation, if it can be proved that development of coal bed methane is the cause. However, if pre-data does not exist for individual water sources or if it cannot be proved that drought is not the cause, these water sources would not be mitigated and wetland/riparian sites and vegetation would become drier and potentially convert to upland vegetation.

Although most natural gas would be collected as water is removed from the coal aquifers, some gases may move upslope through the formation and escape through the soil surface. Where this occurs the vegetation may die back, resulting in dominance of herbaceous species and

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

increased bare ground. These locations would generally be small and scattered along the outcrops of the coal formations, probably affecting less than 10 acres altogether.

Vegetation treatments would become more complex and costly as the density of field development increases. The opportunities to use prescribed burns as a management tool would become more limited, requiring increased use of chemical and mechanical forms of manipulation. These methods decrease the ratio of shrub versus herbaceous species, but primarily influence species already present compared to fire which creates openings for early succession species (especially forbs). Therefore, in areas where the objective is to increase forb composition and there are currently few forb species present in the community, it would be difficult and more expensive to reach this objective using chemical or mechanical forms of treatment.

Direct and indirect impacts to the vegetation resource would be reduced with implementation of and compliance with required best management practices stated in appendix H, applicant voluntarily committed measures (appendix K), the Reclamation Plan (appendix B), and the RMP. However, no measures currently address spreading concentrated runoff back over the land. Therefore, channelization and gulying leading to desertification would occur. Achieving final reclamation goals is dependant upon disturbed soil properties; developing seed sources for native forbs and shrubs; short- and long-term monitoring; future climatic conditions and land-use patterns; and, most importantly, operator commitment. However, the current lack of seed sources for desirable native forbs in the 7- to 9-inch precipitation zone makes any timeline questionable in terms of achieving successful reclamation with desired native species composition. In addition, non-native species, if used in reclamation on state and private lands could expand onto adjacent public lands, requiring some form of both monitoring and control.

The lack of adequate weed control efforts in the first few years of development under the Atlantic Rim pod EAs have already increased weeds and seed banks that would have to be controlled for several years at a minimum. Halogeton has been observed spreading outside areas of disturbance from CBNG development on all land ownerships. There are no applicant voluntarily committed measures to control weeds; therefore, the current trend of weed spread is likely to continue. These populations would continue to pose a threat of expansion onto public lands that would require long-term treatments.

4.5.3.2 Proposed Action

The Proposed Action would directly reduce the extent of existing vegetation cover types. Half of the overall, life-of-project disturbance from the Proposed Action would occur within the first 5 years. The 6,200-acre, life-of-project disturbance would hold true for reclamation of herbaceous species, but not for shrubs habitats to be returned to pre-existing conditions.

Indirect impacts due to dust from roads is expected to affect vegetation adjacent to roads, resulting in additional impacts across 15 to 30 percent of the ARPA. The primary effects expected are reduced photosynthetic capability for plants and reduced palatability of forage. For the purpose of this analysis, dust movement off roads was considered to be between 300 and 1,320 feet along with the estimated total miles of roads needed for gas development in the ARPA. Impacts vary considerably depending on wind speeds, season and duration of soil disturbing activities, and the timing of and amounts of rainfall to wash dust off the vegetation. Impacts to wildlife and livestock may vary depending on the season of use or other critical time

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

periods (i.e., migration) that may change due to annual climate, vegetation health, or management system.

Direct and indirect impacts to vegetation would affect specific plant communities to varying degrees depending on general abundance, browse use, topography, and difficulty of reclamation. The majority of development would occur in mountain and Wyoming big sagebrush vegetation cover types, since they occupy about 85 percent of the ARPA. However, long-term impacts to Wyoming big sagebrush would be much higher than to mountain big sagebrush.

Wyoming big sagebrush plant communities occur on sites with lower precipitation and poorer soils, which increases the difficulty in reclamation and the likelihood that only initial shrub reestablishment may occupy disturbed sites during the estimated 30–50 year life of project. This loss of shrub habitat from direct disturbance, coupled with minor increases in dust drifting off roads making nearby vegetation less usable, would result in up to a 10 percent reduction in available Wyoming big sagebrush habitat on state and private lands. Even though the majority of disturbance would not be in antelope and mule deer crucial winter range, it would be in adjacent transition range. With average browse rates on crucial winter range and adjacent transition range already at moderate levels (40 to 60 percent) during average winters and higher during severe winters, this reduction in usable habitat would lead to increased browse use levels that would result in plant mortality and continue the current downward trend in sagebrush cover and age-class structure.

For the most part, impacts described in this and sections below are primarily about CBNG wells, since the actual number and location of deep natural gas wells is unknown but limited to 200 at this point. However, development of deep natural gas wells in the Wyoming big sagebrush plant community would have the greatest impacts (versus other plant communities), because they would be compounding the impacts already described for CBNG development. In addition, approximately 8 percent of this cover type occurs on moderate to steep slopes that would be affected by increased gully erosion and desertification due to the influence of roads on overland hydrology.

In allotments where increased levels of grazing non-use are requested by the livestock permittees due to the rate and scale of field development, there would be effects to the vegetative resource. Plant material previously removed or trampled by livestock would be left largely ungrazed, resulting in increased litter, soil protection, and reduced runoff and erosion. Plant vigor may improve in some areas, but most allotments with rotational grazing already have good vigor of desired species. Reclamation efforts would benefit without being grazed by livestock. However, grasses would eventually out-compete forbs and shrubs in the absence of livestock grazing. In Wyoming big sagebrush transition and crucial winter range increased grass cover and vigor may, in combination with increased shrub browsing, reduce establishment of shrub seedlings. This would skew the age-class ratio and contribute to the long-term decline in Wyoming big sagebrush cover and density. Therefore, impacts from disturbance to this vegetation cover type would affect its abundance, health, and diversity across the region, exceeding the significance criteria.

Mountain big sagebrush sites occur in areas with higher precipitation and better soils, and should reclaim more easily than Wyoming big sagebrush sites if adequate reclamation techniques are employed. Whether these sites would return to pre-existing levels of sagebrush cover during the 30–50 year life of project is unknown. Following prescribed burns in this area

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

mountain big sagebrush has been documented recovering to original cover levels in 40 to 50 years. In field development, soil profiles and structure is altered, which will likely lengthen time needed for recovery of shrubs. The elevation this species occurs at also precludes it from receiving more than light browsing by big game species before it is protected by winter snow. Approximately one-fourth of this shrub type occurs on moderate to steep slopes, particularly in the vicinity of the Muddy Creek drainage, Muddy Mountain, and the Deep Gulch/Wild Cow area. These sites would be affected by increased gully erosion and desertification due to the influence of roads on overland hydrology. Therefore, impacts from disturbance to this vegetation cover type would affect its health and diversity on locations with moderate to steep slopes, exceeding the significance criteria in these areas. However, acreage loss from disturbance would not affect its overall abundance, health or diversity across the project area.

Alkali sagebrush is the third most common vegetation cover type within the ARPA, but is not common within this region or even within the State of Wyoming. The high clay content in the soils it grows upon has high runoff and severe water erosion potential once the protection of vegetation cover is removed, and increases the difficulty of reclamation. Although this species receives some browse use by wildlife and sheep, the use levels do not approach those documented for Wyoming big sagebrush. Therefore, impacts from disturbance to this vegetation cover type would reduce its overall abundance, and may affect its health and diversity across the region, exceeding the significance criteria.

Mountain big sagebrush/mountain shrub mix vegetation cover types occur on sandier sites around the Sand Hills and on steeper, north and east slopes where snowdrifts provide higher precipitation levels. The steeper slope sites would be avoided, so loss from project disturbance should be minimal. Sites around the Sand Hills contain high amounts of bitterbrush which is important to mule deer during the fall and winter and is not abundant elsewhere in the ARPA. Bitterbrush should be able to be reestablished on these sites, but not within the life of the project; therefore, impacts from disturbance to this vegetation cover type would affect its health and diversity in localized areas. However, acreage loss from disturbance would not affect its overall abundance, health or diversity across the project area.

The ability to reestablish native vegetation on sensitive soil types (i.e., clayey, sands, saline-sodic) is not well documented in this area, but may be in other locations. Although current technology exists to stabilize these areas and minimize soil erosion as revegetation is being carried out, there is currently a lack of local seed sources for native forb and shrub species, and the recovery rate to restore native shrubs (particularly Wyoming big sagebrush and alkali sagebrush) to their pre-existing condition is unknown. This would likely lead to a two-phased reclamation, initially grasses with weed control and 3–5 years later (or longer) interseed grasses with forbs and shrubs when native seed is available. Many of the potential impacts to the vegetation resource would be reduced assuming construction, maintenance, and operation of well pad sites and associated disturbances are in accordance with chapter 2 of this EIS, the Reclamation Plan (appendix B), the BMPs (appendix H), and RMP stipulations.

Surface disturbing activities would increase the potential for new infestation and spread of existing invasive plant species populations. On the other hand, prompt and successful reclamation would reduce the potential for these species to establish and spread. Assuming that existing weed populations on public lands would receive adequate treatments in the future, potential weed expansion onto public lands would not occur; therefore, weeds would not exceed the significance criteria.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.5.3.3 Alternative A (No Action)

Under the no action alternative, direct and indirect vegetation impacts would continue from the Atlantic Rim pods. The lack of adequate weed control efforts in the first few years of the interim drilling period has already increased seed sources for weeds that would have to be controlled for several years at a minimum. Halogeton has been observed spreading outside areas of disturbance from CBNG development. Reclamation and weed control during the interim drilling period is a concern to BLM based on the lack of success. BLM will focus on adaptive management to improve reclamation success to disturbed areas.

The lack of sufficient dust abatement with the Atlantic Rim pods has indirectly impacted vegetation. Based on observations, this has resulted in impacts to an additional 15 to 30 percent of the interim drilling period development areas. Under the no action alternative, indirect impacts from dust would continue to reduce photosynthetic activity and growth in vegetation due to lack of sufficient dust control efforts.

4.5.3.4 Alternative C

Alternative C would proceed with development similar to the Proposed Action, but would limit the acres of disturbance or recommend avoidance to protect sensitive values. Examples of sensitive values are areas with steep slopes, soils with high runoff potential, and big game crucial winter range. Since about 95 percent of the ARPA is affected by one or more restrictions for sensitive values (map M-40), the total acres disturbed on federal minerals would be reduced by about 68 percent, with impacts in different plant communities affected to varying degrees. With less disturbance on public lands, the disturbance on private and state lands would increase 100 percent compared to the proposed action. This would increase disturbance in the mountain sagebrush plant communities on those lands.

For instance, alkali sagebrush grows on clay soils with a high runoff potential, so this community would have less than half the disturbance than a comparable site supporting Wyoming big sagebrush. However, sagebrush sites within 2 miles of active leks that qualify as nesting habitat would also have limited disturbance. In addition, locations on moderate to steep slopes would have reduced surface disturbance compared to sites on gentle slopes; this would further reduce desertification impacts caused by alterations to runoff hydrology from roads. These benefits would affect all plant communities on moderate to steep slopes.

The additional mitigation measures would result in less acreage being disturbed, but some shrub species (Wyoming big sagebrush, Alkali sagebrush) still would not be replaced, removing the community's unique attributes or ability to support other resource values within the life of the project. Although disturbance would be greatly reduced, the allowed levels of disturbance in Wyoming big sagebrush coupled with existing impacts to this community, would continue the current downward trend in sagebrush cover and age-class structure, thereby exceeding the significance criteria.

The doubling of disturbance on private and state lands, where there are no operator committed measures to control weeds, address erosion issues, and meet reclamation standards would increase weed and erosion effects that would carry onto adjacent public sections. Mountain shrub communities important to wintering big game and other wildlife species would potentially be more affected through fragmentation or loss of habitat due to construction activities. This

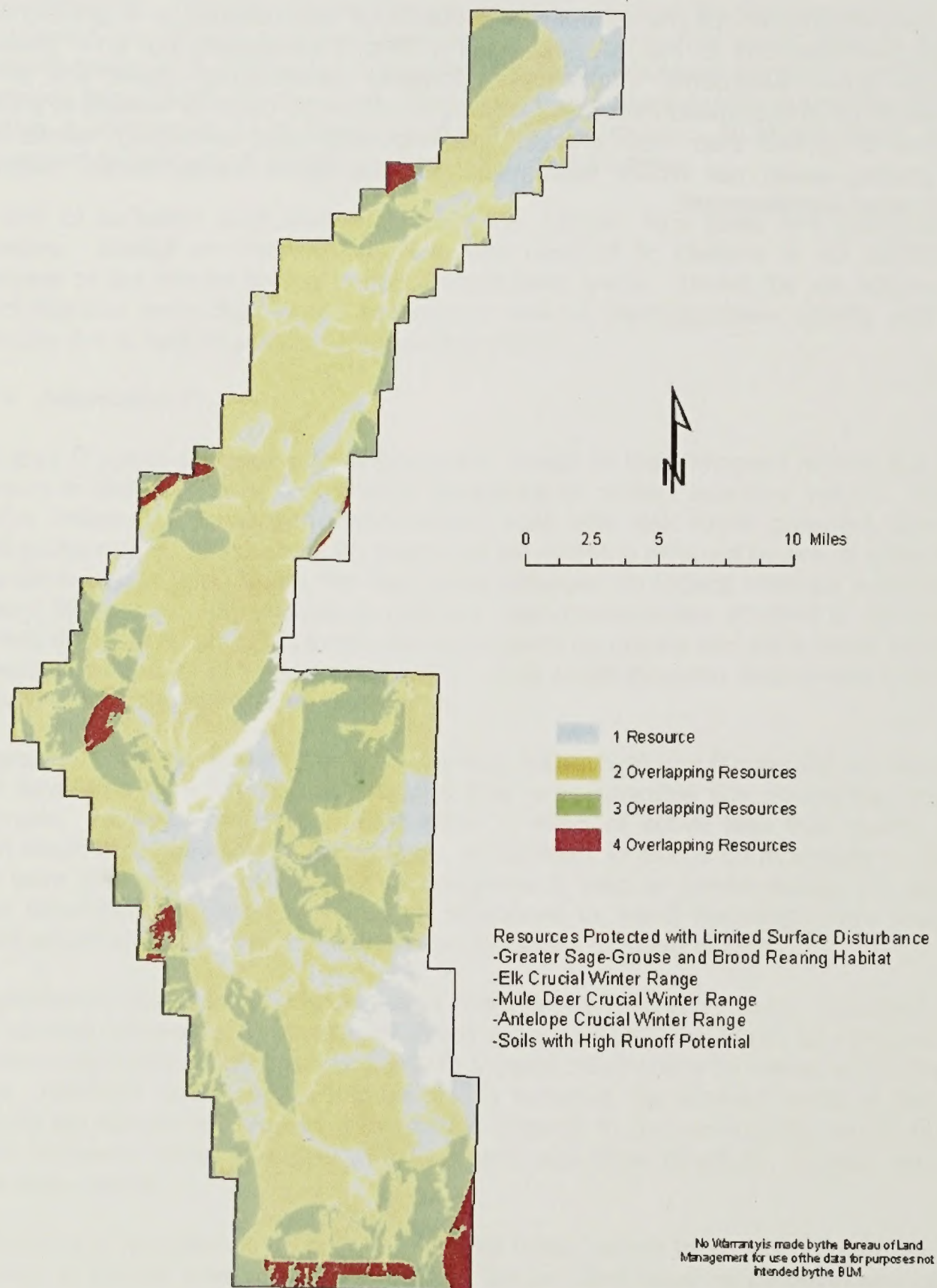
Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

would have effects to both upland and riparian plant communities, and lead to weeds exceeding the significance criteria on public lands.

This alternative would continue the likelihood of requests for total non-use of all grazing use by the livestock permittee due to the rate and scale of field development, but on a pasture or regional scale within allotments. Within these smaller development areas, the principle difference would be in reclamation success, as there would be no need for fencing of pads and other facilities to protect them from grazing until vegetation was sufficiently reestablished. Livestock grazing would not hinder reclamation success which would further reduce the potential for weed establishment.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-40. Alternative C—Resources with Limited Surface Disturbance Mitigation Measure.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.5.3.5 Alternative D

Alternative D would proceed with development similar to the Proposed Action, but would vary allowable disturbance within two categories and limit the acres of disturbance at any one time. Total disturbance acres would be 13,600 acres (13,000 new disturbance and approximated 600 acres of existing disturbance) or about 18 percent less than the Proposed Action. This alternative also has a goal of an average of 6.5 acres/well pad and a goal of less than 6.5 acres/well pad disturbance in Category A areas. Vegetation in avoidance areas would generally be protected, unless influenced by activities adjacent to these sites.

Shrub cover (Wyoming big sagebrush, Alkali sagebrush) still would not be replaced, removing the ability to support other resource values within the life of the project, thereby exceeding the significance criteria.

This alternative would continue the likelihood of requests for total nonuse of all grazing use by the livestock permittee due to the rate and scale of field development, but coordinated annually with permittees to allow them to plan around disturbance within allotments. Within these development areas, the principle difference may be in reclamation success. In locations with total nonuse, there would be no need for fencing of pads and other facilities to protect them from grazing until vegetation was sufficiently reestablished. Livestock grazing would not hinder reclamation success resulting in higher herbaceous cover on reclaimed sites. An increase in herbaceous cover would further reduce the potential for weed proliferation but may lower the establishment of shrub species. Therefore, impacts from disturbance to Wyoming big sagebrush and alkali sagebrush would affect its abundance, health, and diversity across the region, exceeding the significance criteria.

Surface disturbing activities would increase the potential for new infestation and spread of existing invasive plant species populations. On the other hand, prompt and successful reclamation would reduce the potential for these species to establish and spread. Assuming that existing weed populations on public lands would receive adequate treatments in the future, potential weed expansion onto public lands would not occur; therefore, weeds would not exceed the significance criteria.

4.5.4 Impacts Summary

Impacts from the Proposed Action would include direct removal of acreage of vegetation communities, and an indirect loss of usability from dust, thus decreasing abundance and redistributing use by livestock and wildlife that use these native species throughout the life of the project (or longer). Disturbance in Wyoming big sagebrush communities within mule deer and antelope transitional and crucial winter range would exacerbate the existing downward trend and add to the management issues that led to the failure of Rangeland Health Standards #3 (Upland Vegetation) and #4 (Wildlife Habitat). Sites located in the mountain big sagebrush cover type would recover with reclamation. In addition, the desertification of rangelands due to changes in overland hydrology on moderate and steep slopes would affect more than one-third of the ARPA. Project implementation would potentially reduce the amount and function of wetlands and other waters of the U.S due to accelerated erosion and sedimentation from adjacent moderate and steep slopes (appendix K, section K.1.3.7.2). Disturbance to most vegetation cover types would exceed the significance criteria and, with adequate control, weed presence would not exceed significance criteria.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Impacts for Alternative A would include disturbed land and associated loss of vegetation as described in the associated Atlantic Rim pod environmental assessment. However, the increase in presence and spread of weeds during the interim drilling period is a concern and must be addressed to achieve successful reclamation.

The additional mitigation measures for Alternative C would result in less acreage on public land being disturbed (but with the possibility of a corresponding increase in disturbance on private and state lands). Some shrub species (Wyoming big sagebrush, Alkali sagebrush) still would not be replaced, removing the ability to support other resource values within the life of the project, and mountain shrub communities and erosion effects to plant communities in the checkerboard land pattern would increase, thereby exceeding the significance criteria. Weed presence without operator commitment to treat weeds on private and state lands that would spread to public land would also exceed the significance criteria.

Alternative D would result in 18 percent less acreage being disturbed than the Proposed Action, and with less disturbance in Category A areas. However, in general, impacts would be the same as for the Proposed Action.

4.5.5 Additional Mitigation Measures

There would be no additional mitigation measures for the Proposed Action, Alternative A, or Alternative D.

Additional mitigation measures for Alternative C are detailed in appendix L "Resource Concerns and Associated Protection Measures Proposed under Alternative C".

4.6 Rangeland Resources

4.6.1 Introduction

Impacts to range resources would result with implementation of the Proposed Action or any of the action alternatives. Potential impacts would occur throughout the life of the project, due to vegetation and soil disturbance associated with construction activities, reclamation, weed control, road issues (i.e., dust and animal collisions), fence maintenance, water management, and increased recreational use by the public.

4.6.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objective associated with rangeland resources:

- To enhance livestock grazing while maintaining a balance between economic uses and the enhancement of wildlife habitat, watershed, and riparian areas, while maintaining range condition at, or improving range condition toward, the potential for the ecological site.

Impacts to rangeland resources would be potentially significant if:

1. Resource management actions result in greater than 10 percent permanent reduction in AUMs available for livestock grazing in a given allotment,

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

2. Resource management actions reduce or eliminate the opportunity to run the livestock of choice, and
3. Wyoming BLM standards for Health Rangelands are not met.

4.6.3 Direct and Indirect Impacts

4.6.3.1 Direct and Indirect Impacts Common to All Alternatives

The ARPA includes lands that are located within 31 grazing allotments (described in section 3.6, table 3-31, and on map M-20). In many cases, the boundaries of these allotments extend beyond the boundaries of the ARPA; therefore, discussion of impacts will focus on the 20 allotments primarily affected. The remaining 11 allotments would have similar impacts, but very minor in scale. Under the Proposed Action and all alternatives, livestock grazing would continue throughout the duration of the project with stocking rate adjustments (and requests for temporary non-use) made annually by each livestock operation.

The primary impact to grazing resources would be short-term loss of available forage as a result of construction and production-related disturbance. Available forage would be reduced during drilling and field development and reclaimed as soon as feasible under direction of the Reclamation Plan (appendix B) and BLM. A permanent loss of forage would occur under any action approved for the construction of roads, portions of drill pads, and ancillary facilities that remain permanent during the life of the project. However, successful short-term reclamation of pipelines, portions of pads not necessary for long-term operations, and any other related disturbances should replace this short-term loss of forage. The potential exists for increased death loss of young livestock due to vehicle collisions following construction of new and higher speed roads.

The proposed project would result in increased traffic and increased speeds on the improved roads within the ARPA, particularly during the drilling and field development phase. The potential for livestock/vehicle collisions would be increased, especially during the calving/lambing season. Carbon County has already posted speed limits on the Twenty Mile road south of Rawlins. The potential also exists for disruptions to livestock management. Traffic along roads that pass through shipping pastures or by corrals when in use may interrupt or complicate this work, extending the time and increasing the cost to complete them. Herding of animals through areas being developed or moving around them would increase the complexity and time to accomplish these tasks. In some allotments, management flexibility may be sacrificed to avoid or to minimize these operational impacts. Benefits of better roads to livestock operations are varied and substantial in nature. They include improved access for viewing the allotment, facilities and animals, greater likelihood of observing and doctoring sick animals, and improved capability for trucking animals in or out of an allotment.

There is also potential for damage to BLM and livestock operator fences, gates, and cattle guards from the movement of heavy trucks, drilling equipment, and heavy construction equipment. The involved mineral companies would promote (if they don't already) a policy to report and correct damage to livestock facilities as quickly as possible, including contacting the permittee and the BLM. Closed gates that are left open or are damaged usually result in a scattering of livestock off the allotment and a considerable amount of time and expense for the livestock operator to roundup the loose livestock and return them to the pasture. This may

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

affect their breeding program, reduce weight gains of livestock, and reduce time available for other work.

Water resources would be affected by the proposed project. New water locations may be established in self-contained systems, similar to two water troughs and tanks already authorized on lands of Weber Ranch in the Doty Mountain allotment. These self-contained water systems help improve water distribution and provide water otherwise not available in dry years. Storage tanks and pipelines may be supplemented with water from CBNG development that may save in pumping costs during the life of the project. Existing water sources that dry up or have reduced flows due to water drawdown associated with gas field development may affect livestock operations in the short-term until alternative water sources are developed. If this does occur, mitigation would occur if it can be proven that the reduction in water is a result of CBM development, and would consist of either CBNG water of similar quality being substituted to replace the same volume of water no longer flowing or creating an alternate water source.

Disturbance of soils and increased vehicle activity would increase the potential for introduction, establishment, and spread of invasive non-native species. This can reduce forage availability and animal weight gains, in addition to affecting trail routes and animal health, particularly increasing death loss with sheep. Expansion of weeds and increased erosion from private and state lands without operator commitment to control them onto adjacent public lands would likely occur. Recently observed expansion of halogeton from disturbed sites into adjacent native rangelands demonstrates the concern that this problem can spread beyond sites of disturbance and affect thousands of acres. Prompt reclamation of disturbed sites would lessen the introduction and spread of weeds and would reduce the impact on livestock operations. However, lack of adequate weed control would lead to increases in invasive species. In the case of halogeton, this would likely eliminate the ability to graze sheep in this area. This would potentially lead to non-use of 1,588 AUMs and could result in one of two sheep operations going out of business due to lack of ability to graze and lamb sheep in other locations.

4.6.3.2 Proposed Action

The Proposed Action would result in an estimated initial disturbance of about 15,800 acres, which represents about 6 percent of the total land area of the combined 20 grazing allotments used by twelve livestock operations. This acreage of disturbance would result in the short-term loss of 2,026 AUMs. This development would happen incrementally, with reclamation of short-term disturbances probably making up for a portion of the forage lost. This is due to initial reclamation efforts being focused on site stability, with vegetation dominated by herbaceous (grass and forb) species. Since 91 percent of livestock AUMs are cattle, and cattle prefer grasses, reclamation should not just replace forage lost, but result in higher production of desired species. During the life of the project, this total amount of disturbance is estimated to decrease to about 6,200 acres, or between 2 and 3 percent of the combined land area of the allotments. This amount of forage affected is far less than the normal adjustments permittees have to make for market change or drought, for instance. Therefore, the loss of forage from disturbance from construction and production activities should be minimal in the short-term and may actually increase available forage in the long-term, and therefore benefit livestock operations. However, this may be more than offset by the lack of any commitment by the companies to control weeds on private and state lands.

Roads would contribute to increased dust that settles on vegetation resulting in lower palatability and shifting of use to other locations. Increased dust may also affect animal health by

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

increasing the likelihood of ailments such as dust pneumonia. These impacts could reduce weight gains or require lowering stocking rates in affected allotments. Application of measures to reduce dust, such as road construction and treatments, would reduce these impacts on public lands, but usable forage on state and private lands could be reduced by 15 to 30 percent, leading to more concentrated livestock use in dust-free locations. Roads on moderate to steep slopes that result in long-term changes in overland hydrology and desertification impacts below these locations could also lead to lower weight gains or require reduced stocking rates.

The greatest affect upon livestock operations will be the sum of the impacts described in section 4.6.3.1 and the paragraphs above, which is also dependent on the rate and extent of development and what amount of each operation it will impact. Although chapter 2 describes a 15- to 20-year development phase, approximately half of the projected 2,000 wells would be completed in the first 5 years. Based upon this information and where pods have been developed in the interim drilling period, impacts would be greatest (in descending order) upon five allotments: Doty Mountain, Cherokee, Fillmore, East Muddy, and Sixteen Mile allotments.

The Cherokee allotment is almost entirely within the ARPA and would have the next highest number of wells (approximately 300 in first 5 years) that affect seven different livestock operations. One operation consisting of 950 AUMs, uses this allotment for 6 months per year and would be most affected by disruptions due to development activities. The remaining six operations use the allotment more seasonally for about 2 months each and have other allotments where they could make some adjustments. Spring lambing occurs in May and June, which would receive some protection from disturbance due to their proximity to greater sage-grouse nesting habitat, as long as seasonal timing stipulations are required. This habitat used for spring lambing use, involving two operators (1,588 AUMs), would be difficult to replace in another location and is further complicated by the impact from weeds discussed above.

The Fillmore allotment would be the third most affected allotment with up to 200 wells in the first five years. This allotment is about two-thirds contained within the ARPA and has one livestock operation grazing cattle in the spring and summer. Impacts would be similar to Doty Mountain, with 3,374 BLM-permitted AUMs within this allotment. Since Fillmore is in the checkerboard, these AUM numbers will actually double, and the AUMs affected in Doty Mountain would increase about 50 percent also due to private lands.

Although well numbers would next be highest in East Muddy and Sixteen Mile allotments, the impacted acres and AUMs would likely only affect 10 percent or less of each livestock operation. Remaining allotments would be affected as long-term build-out from the pods occur, but development would not likely be as intense as those mentioned above. Knowledge gained in early field development would help reduce the impact upon outlying allotments.

4.6.3.3 Alternative A (No Action)

As explained in section 2.1.2, the no action alternative would allow the operators to only complete development of wells (200 maximum) already approved under the Atlantic Rim pod EAs and as guided by the IDP (appendix A). This affects the Doty Mountain, Cherokee, Fillmore, and Sixteen Mile allotments, listed in order by the number of wells in each (high to low). Due to this low number of wells spread across four good-sized allotments, there would be minor impacts in terms of forage lost or reduction in usability due to dust. This impact should be replaced by forage returning to use due to reclamation of short-term disturbances; however,

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

existing weeds and expansion with development under the interim drilling period where adequate treatment has not taken place will continue to pose problems for livestock operators.

Impacts of greater concern are those relating to death loss from vehicle collisions or poisonous plants and disruption of livestock management actions such as vehicular traffic through shipping pastures or altering sheep trailing routes to avoid facilities and halogeton. At this scale of development, these impacts should be negligible if coordination with permittees, field personnel awareness, and weed control measures occur. Whether existing water sources would be impacted due to water drawdown pumping is unknown. The potential for damage to livestock control structures would be minimal due to the level of development. Benefits to livestock operations from existing or new water sources and road infrastructure as a result of CBNG development would continue or be improved.

4.6.3.4 Alternative C

Alternative C would proceed with development across the ARPA similar to the Proposed Action alternative, but would limit the acres of disturbance on sensitive sites and to protect specific resource values and sites on public lands. Examples of some of these sites are steep slopes, soils with high runoff or erosion potential, big game crucial winter range, greater sage-grouse nesting habitat, and lambing areas. Since about 95 percent of the ARPA is affected by one or more restrictions for sensitive values (map M-40), the total acres disturbed on BLM-administered lands would be reduced by about 68 percent. Total acres disturbed on private and state lands would be similar to that described under the Proposed Action or could increase to compensate for lower disturbance limits on public lands. This would result in an estimated initial disturbance of about 13,286 acres, and would result in the short-term loss of 1,703 AUMs. In addition, field development would be planned on a pasture or regional basis within allotments with the livestock operators. This form of development would reduce impacts to livestock operations and allotments to varying degrees.

In general, allotments with more critical wildlife habitat may have lower limits on disturbance that would result in reduced forage lost or made unusable by dust. Allotments with soils sensitive to disturbance may require lower limits on disturbance or methods that would reduce erosion or speed up reclamation that would also lower impacts to livestock operations. However, even though the magnitude of disturbance is reduced, the number of wells and activities to develop them and associated facilities would still be the same as in the Proposed Action.

The discussion above would not change the most impacted allotments described in the Proposed Action section, which are Doty Mountain, Cherokee, Fillmore, East Muddy, and Sixteen Mile. Although impacts to vegetation, soils, and hydrology have all been reduced significantly on public lands, and these will benefit livestock operations, many factors associated with a fast rate of field development still exist. These include increased death loss due to vehicle collisions, unusable forage and shifts in distribution of use due to dust, disruptions to livestock management actions, and potential for damage to livestock control facilities. Planning field development by pastures or regions within allotments would allow livestock operators to plan and work around the disruptions associated with development, instead of having these occur across the whole allotment. This may still lead to reductions in livestock use through requests for temporary nonuse, but at a level where ranchers could still continue to graze a majority of their allotments.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.6.3.5 Alternative D

Alternative D would proceed with development across the ARPA similar to the Proposed Action alternative, but with two categories of disturbance goals and a limit of 7,600 acres of unreclaimed disturbance at any one time. In general, allotments with more resource values requiring avoidance or limited disturbance (Category A on map M-7) would result in reduced forage lost. However, even though the magnitude of disturbance is reduced, the number of wells and activities to develop them and associated facilities would still be the same as in the Proposed Action. This would result in an estimated initial disturbance of about 13,000 acres, and would result in the short-term loss of 1,667 AUMs.

The discussion above would not change the most impacted allotments described in the Proposed Action section, which include Doty Mountain, Cherokee, Fillmore, East Muddy, and Sixteen Mile. Factors associated with a fast rate of field development still exist which include increased death loss due to vehicle collisions and poisonous plants, unusable forage and shifts in distribution of use due to dust, disruptions to livestock management actions, and potential for damage to livestock control facilities. Annual coordination and planning meetings would help livestock operators plan and work around the disruptions associated with development. This may still lead to reductions in livestock use through requests for temporary nonuse, but at a level where ranchers could still continue to graze a majority of their allotments.

4.6.4 Impacts Summary

4.6.4.1 The Proposed Action

Range impacts associated with the Proposed Action would include disturbed land and associated loss of available forage. Implementation of the Proposed Action would result in an initial loss of about 2,026 AUMs due to actual disturbance to forage during construction activities. During the life of the project, this total is estimated to be replaced and probably exceeded assuming reclamation efforts are successful. However, 1,588 sheep AUMs may not be usable due to poisonous plant expansion and lack of weed control on private and state lands that may spread to adjacent public lands. An additional 2,000 to 4,000 AUMs may also be unusable on an annual basis due to dust from roads. In allotments with the highest rates and extent of field development, there would likely be reductions in livestock use that could total 20,000 AUMs (both BLM and private) annually in increased requests for temporary nonuse by six or more livestock operations.

Based on the assumptions and estimates contained in this assessment and experiences with gas field development in adjacent areas, the Proposed Action would result in significant impacts to livestock operations due to increased death loss, unusable forage due to dust and expansion of non-native poisonous plants, declining rangeland health and forage productivity, and disruptions to livestock management actions. The potential would exist for damage to livestock control facilities and increased labor in corrective actions.

4.6.4.2 Alternative A (No Action)

Range impacts associated with the no action alternative would include disturbed land and associated loss of available forage as described in the Atlantic Rim pod EAs and associated POD environmental assessment. This would amount to less than 10 percent of the forage loss described under the Proposed Action, or between 150 to 200 AUMs. Since this impact is

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

spread across four large allotments, the short-term impact should be minimal. During the life of the project, this total is estimated to be replaced or exceeded assuming reclamation efforts are successful.

Due to the small scale of development in this alternative, there would be minimal impacts in terms of unusable forage due to dust, declining rangeland health and forage productivity, potential for damage to livestock control structures, and disruptions to livestock management actions. The level of livestock death loss will be dependent on future weed control efforts to control existing and expanding weed populations.

4.6.4.3 Alternative C

Range impacts associated with Alternative C would include disturbed land and associated loss of available forage. Implementation of the Alternative C would result in an initial loss of about 1,703 AUMs. During the life of project, this total is estimated to be replaced or exceeded assuming reclamation efforts are successful. However, an additional 3,000 to 6,000 AUMs may be unusable on an annual basis due to dust from roads, once full-field development is completed. In allotments with the highest rates and extent of field development, there would likely be annual requests for temporary nonuse that could total 5–10,000 AUMs by six or more livestock operations. However, this would be reduced (depending on how each livestock operation is affected) by planning development on a pasture or regional basis within each allotment.

Based on the assumptions and estimates contained in this assessment and experiences with gas field development in adjacent areas, Alternative C would result in significant impacts to livestock operations due to increased death loss, unusable forage due to dust, declining rangeland health and forage productivity, and disruptions to livestock management actions. The potential would exist for damage to livestock control facilities and increased labor in corrective actions.

4.6.4.4 Alternative D

Range impacts associated with Alternative D would include disturbed land and associated loss of available forage. Implementation would result in an initial loss of about 1,667 AUMs, which is less than Alternative C. During the life of the project, this total is estimated to be replaced or exceeded assuming reclamation efforts are successful. However, 1,588 sheep AUMs may not be usable due to poisonous plant expansion and lack of weed control on private and state lands that may spread to adjacent public lands. An additional 2,000 to 4,000 AUMs may be unusable on an annual basis due to dust from roads, particularly on private and state lands, once full-field development is completed. In allotments with the highest rates and extent of field development, there would likely be reductions in livestock use that could total 20,000 AUMs (both BLM and private) annually in increased requests for temporary nonuse by six or more livestock operations.

Based on the assumptions and estimates contained in this assessment and experiences with gas field development in adjacent areas, Alternative D would result in significant impacts to livestock operations due to increased death loss, unusable forage due to dust, and expansion of non-native poisonous plants, declining rangeland health and forage productivity, and disruptions to livestock management actions. The potential would exist for damage to livestock control facilities and increased labor in corrective actions.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.6.5 Additional Mitigation Measures

4.6.5.1 The Proposed Action

Speed limits would be enforced by companies advising and disciplining their employees and contractors as necessary to comply with speed limits.

The operators would coordinate annually or more often when necessary with affected livestock operators to discuss (1) problems encountered during the past grazing season, (2) agreed-upon corrective actions, and (3) planned energy development and operations during the next grazing season. This meeting needs to occur on a date early enough to allow grazing permittees sufficient time to make decisions and allocate their resources for the upcoming grazing season.

4.6.5.2 Alternative A (No Action)

The operators would coordinate annually or more often when necessary with affected livestock operators to discuss (1) problems encountered during the past grazing season, (2) agreed-upon corrective actions, and (3) planned energy development and operations during the next grazing season. This meeting needs to occur on a date early enough to allow grazing permittees sufficient time to make decisions and allocate their resources for the upcoming grazing season.

4.6.5.3 Alternative C

No additional mitigation measures are proposed for Alternative C over and above that detailed in appendix L "Resource Concerns and Associated Protection Measures Proposed Under Alternative C".

4.6.5.4 Alternative D

Speed limits would be enforced by the companies advising and disciplining their employees and contractors as necessary to comply with speed limits.

The BLM would require that the operators establish speed limits in the project area and promote adherence to them, and erect signs in lambing/calving areas, shipping pastures, or adjacent to working corrals to warn vehicle operators.

The operators would coordinate annually or more often when necessary with affected livestock operators to discuss (1) problems encountered during the past grazing season, (2) agreed-upon corrective actions, and (3) planned energy development and operations during the next grazing season. This meeting needs to occur on a date early enough to allow grazing permittees sufficient time to make decisions and allocate their resources for the upcoming grazing season.

The operators would report damage to livestock and livestock facilities as quickly as possible to BLM and affected livestock operators.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.7 Wildlife

4.7.1 Introduction

The principal wildlife impacts likely to be associated with the Proposed Action or action alternatives include (1) direct and indirect loss of wildlife habitats, (2) displacement of some wildlife species from increased human access and activity, (3) an increase in the potential for collisions between wildlife and motor vehicles, (4) an increase in stress to wildlife and (5) disruption of life history requirements of a species or population segment.

In addition, an analysis of potential wildlife concerns within each section of the ARPA was conducted so that operators could take the locations of these potential concerns into account when planning and selecting eventual well locations. Mitigation measures that correspond to the respective types of wildlife impacts within any given section would be implemented.

The primary wildlife resource concerns known to be present within the ARPA include big game crucial winter/transitional ranges; big game migration routes; overlapping big game crucial winter range (multiple species); leks, nesting habitat, and severe winter relief habitat of greater sage-grouse leks and nesting habitat of Columbian sharp-tailed grouse; and raptor nests.

The wildlife map (map M-29) represents the currently known locations of wildlife resource concerns within the ARPA. As more field data are gathered, additional areas that include wildlife resource concerns may be identified and mapped. If development occurs in areas of overlapping wildlife resource concerns, mitigation measures for each individual resource would be implemented. This approach provides the operators with information that can be used when developing gas well placement plans. Planned placement of disturbances may avoid individual wildlife resource concerns or overlapping concerns present within a section.

4.7.2 Impact Significance Criteria

The Great Divide Resource Area RMP ROD (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with wildlife resources:

- To provide habitat quality (food, cover, space, and water) adequate to support a natural diversity of wildlife and fisheries including big game; upland game; waterfowl; non-game species; game fish; sensitive, threatened, and endangered species; and species of special management interest in Wyoming as well as to assist in meeting goals of recovery plans.
- To maintain or improve vegetation condition or avoid long-term disturbance in high priority standard habitat sites and fisheries areas.
- To maintain or improve overall ecological quality, thus providing good wildlife habitat, within the constraints of multiple-use management in moderate and low priority standard habitat sites.

The following criteria were considered in the assessment of impacts associated with the Proposed Action and alternatives and are the same as those contained in the Draft Rawlins RMP DEIS (USDI-BLM 2004c):

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

1. Substantial loss of habitat function or disruption of life history requirements of a species or population segment that would make them eligible for listing under the ESA.
2. Decreased viability or increased mortality of threatened and endangered, proposed, and candidate species or reduction or alteration of their critical habitats.
3. Management actions that result in substantial disruption or irreplaceable loss of vital and high value habitats as defined in the WGFD (2004c) Mitigation Policy.
4. Substantial loss of habitat function or disruption of life history requirements of special status species that would preclude improvement of their status. Habitat function means the arrangement of habitat features and the capability of those features to sustain species, populations, and diversity of wildlife over time (WGFD 2004c).

4.7.3 Direct and Indirect Impacts

4.7.3.1 Direct and Indirect Impacts Common to All Alternatives

Applicant voluntarily committed measures (appendix K) and the BMPs (appendix H) would be implemented under all alternatives. The Wildlife Monitoring and Protection Plan (appendix E) would be followed to prevent, reduce, and detect impacts to wildlife and fish species throughout the life of the project. This plan serves two purposes. One is to describe the protocols to monitor wildlife responses, habitats, behavioral shifts, etc. The other is to provide protocols to protect wildlife species and track the effectiveness of the monitoring plan. BMPs implemented for other resource concerns may provide indirect protection for a variety of wildlife species.

Wildlife habitats directly affected by the proposed project include areas that are physically disturbed by the construction of pads, roads, pipelines, and production facilities; wildlife habitats indirectly disturbed include areas surrounding directly impacted habitats. Disturbance during construction and production, such as human presence, dust, and noise may displace or preclude wildlife use of disturbed areas. Wildlife sensitivity to these impacts varies considerably with each animal species.

Prohibiting construction, drilling, and other activities potentially disruptive to wildlife during sensitive time periods (i.e., winter, brood-rearing) would minimize the probability of displacement, nest abandonment, or reproductive failure during these critical times of the year. To reduce human presence, remote monitoring of project facilities, gating of roads, and noise reduction techniques should be used to the greatest extent possible during the production phase. However, habitat loss would still occur outside of this time period, as development would be allowed. In addition, it does not address the displacement of animals/loss of critical habitat due to the presence and operation of wells, facilities, and roads after construction is complete.

Displacement is unavoidable in the short term under all action alternatives, and this displacement has the potential to have the most significant effect on wildlife. Avoidance of disturbed areas would result in wildlife displacement from an area larger than the actual disturbed sites. The extent of displacement would be related to the duration, magnitude, and the visual prominence of the activity, as well as the extent of construction and operational noise

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

levels above existing background levels. Visual prominence of facilities is dependent upon surrounding topography.

Displacement would result in local reductions in wildlife populations if adjacent, undisturbed habitats are at carrying capacity. In this situation animals are either forced into less optimal habitats or they compete with other animals that already occupy unaffected habitats. Possible consequences of such displacement are lower survival, lower reproductive success, lower recruitment, and ultimately lower carrying capacity and reduced populations (WGFD 2004d).

Reaction of animals to noise and human presence varies depending on the intensity of the noise source and whether it is continuous or intermittent. Transient loud noises would provoke alarm responses; however, many animals learn to ignore more constant, lower-level noise sources that are not associated with negative experiences such as being chased or hunted (Busnel 1978).

The extent of wildlife displacement is impossible to predict for most species since the response severity varies from species to species and can even vary between different individuals of the same species. After initial avoidance, some wildlife species (usually certain birds and rodents and to a lesser extent deer and pronghorn) may acclimate to the activity and begin to reinvade areas previously avoided. This acclimation and reoccupation would be expected to occur following construction and drilling when the project moves into the production phases where less noise and human activity would take place.

Construction and drilling noise have the potential of affecting wildlife species at the project site as well as areas surrounding disturbance sites. Man-made construction such as well pads and roads can reduce use of surrounding habitat by wildlife. These impacted sites reduce foraging due to the direct loss of native vegetation from ground disturbance. In addition, there is an area surrounding these sites that tends not to be used due to the increased human activity. This zone can extend up to 0.625 mile from the developed area for pronghorn (Easterly et al. 1991) and from 0.6 to 1.2 miles for elk depending upon the season (Powell 2003). Consequently, development impacts to wildlife can extend farther off site than the actual amount of disturbed area. Although some individual animals can habituate to the increased infrastructure, it is generally assumed that, over all, the increased human footprint on a previously lightly developed area is detrimental to big game species. In addition to the avoidance response, increased human presence intensifies the potential for wildlife-human interactions ranging from the harassment of wildlife to poaching and increased legal hunting pressure. Also, increased traffic levels on new and existing roads could increase the potential for wildlife-vehicle collisions. Following drilling and well completion operations, noise levels would be reduced because well pumps would be powered by muffled generators. As a result, species might acclimate to the well pad production facilities and use habitats immediately adjacent to such sites. This has been observed at other natural gas production sites in Wyoming.

Direct habitat loss from construction would equal approximately 6 percent of the project area. In addition, dust would directly and indirectly impact 15–30 percent more acreage (section 4.5.3.1). These impacts would include habitat avoidance. Indirectly, this may increase inter- and intra-species competition for forage and thermal cover. In areas already fully occupied, density-dependant species would be further displaced, possibly outside of the project area. This may force animals to use lower quality habitats, which may lead to a reduction in reproduction rates or an increase in predation. The long-term loss/reduced usability of shrub habitat would lead to an increase in use on remaining shrub habitats. This increase of use would then lead to a

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

long-term reduction of shrub habitats outside the immediate project disturbances. A further reduction of shrub habitat from die-off caused by overuse would further reduce the habitat quantity and quality available in the long term, resulting in a significant impact.

Juniper/true mountain mahogany/serviceberry/silver sagebrush/bitterbrush plant communities would be avoided across the project area. This would aid in efforts to restore them to a more healthy condition to meet Rangeland Health Standard #3. These vegetation communities provide important habitat components for big game and grouse.

Habitat fragmentation and isolation are difficult to determine and vary species to species, but they could occur as a result of gas field developments, which are typically configured as point and linear disturbances scattered throughout broader areas. Although these types of disturbances do not usually create physical barriers to wildlife movement, the effective use of adjacent undisturbed habitats could diminish as densities of well pads, ancillary facilities, and roads increase.

Reclamation of disturbed areas along pipeline ROWs, road ROWs, and unused portions of well pads would result in re-establishment of vegetation in these areas over a relatively short time period. Revegetation would continue with the subsequent reclamation of abandoned well sites. Grasses and forbs are expected to become established within the first several years following reclamation; however, shrub re-establishment to pre-disturbance levels would not be achieved during the life of this project. Consequently, the total acres disturbed would constitute a long-term loss of shrubs and would not be usable by species dependant upon the shrub component for forage or shelter.

To protect breeding grounds and raptor nest sites, the BLM places a buffer around leks and nests where CSU is stipulated (USDI-BLM 1990). The buffer around the leks located within the project area covers 8,440 acres or 3.1 percent of the ARPA. The buffer around nests covers 17,846 acres or 6.6 percent of the project area. Therefore, most these areas would remain undisturbed for the life of the project.

General Wildlife (Species Other than Described in Sections Below)

The disturbance of wildlife habitat would reduce habitat availability for a variety of small birds and mammals. The temporary disturbances that would occur during the 20-year construction period would tend to favor early succession wildlife species, such as ground squirrels and horned larks, and would have more impact on mid-to-late-succession species, such as sage sparrows, sage thrashers, and voles. The long-term disturbance acres would have a minor effect on wildlife species not dependant upon shrubs. In addition to the direct disturbance acreage, dust would directly and indirectly impact 15 to 30 percent more acreage (section 4.5.3.1). These impacts would include habitat avoidance by birds, mammals, and insects. Indirectly, this may increase inter- and intra-species competition for nesting and foraging areas. In areas already fully occupied, density-dependant species would be further displaced possibly outside of the project area. This may force animals to use lower quality habitats, which may lead to a reduction in reproduction rates or an increase in predation.

The primary songbirds (common and BLM-sensitive species) that may be displaced by the reduction in habitat are vesper sparrow, green-tailed towhee, lark sparrow, sage sparrow, sage thrasher, loggerhead shrike, and Brewer's sparrow. Although there is no way to accurately quantify these changes, the displacement would be long term. Birds are highly mobile and would disperse into surrounding areas and use suitable habitats to the extent that they are

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

available. The long-term loss/reduced usability of shrub habitat would lead to an increase in use by all species including big game (See big game section below) on remaining shrub habitats. This increase of use would then lead to a long-term reduction of shrub habitats outside the immediate project disturbances. A further reduction of shrub habitat from die-off caused by overuse would further reduce the habitat quantity and quality available for shrub-dependant birds. Standard mitigation measures would indirectly help songbirds during critical time periods; however, impacts on nesting and foraging habitats would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria (criteria numbers 3 and 4).

The primary small mammals found on the project area include, but are not limited to, cottontail rabbits, deer mice, various vole species, pocket gophers, white-tailed jackrabbits, Richardson's ground squirrels, and white-tailed prairie dogs. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be minor, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area following interim reclamation. Most of these species would benefit from an increase in grass-dominated vegetation from reclamation.

Development of the project may result in some direct mortality of small birds and small mammals from vehicle collisions; however, this mortality is expected to be negligible and is not likely to significantly reduce populations within the ARPA.

Big Game

Impacts to big game species may include (1) the removal and modification of habitat, (2) displacement due to increased human activities, (3) increased potential for vehicular collisions due to increased traffic levels on existing highways, and (4) increased potential harvest success due to easier access. The magnitude of disturbance to big game species would depend upon the season the area is used by each species, the ability of a species to habituate to disturbance, the corresponding drilling schedule, and the density of well field development. In addition, some big game animals may not move to other habitats or other suitable habitats may not be available to them. Therefore, the inability to relocate would result in increased stress from competition for forage and cover.

The WGFD classifies big game crucial winter range as vital habitats and recommends that habitat function be maintained so that the location, essential features, and species supported by the habitat are unchanged (WGFD 2004c). The application of BLM seasonal restrictions to prevent drilling on crucial winter range between November 15 and April 30 reduces the displacement and disturbance of big game during the most critical season. During operations, mitigation measures such as remote monitoring and telemetry would be used to reduce, but not completely eliminate, impacts to big game.

Timely reclamation of well pads, pipelines, and ROWs would provide grass and forb forage within a few years, while sagebrush and other important shrub species would require longer for re-establishment to pre-disturbance levels. With average browse rates on crucial winter range and adjacent transition range already at moderate levels (40–60 percent) during average winters (Warren 2006) and higher during severe winters, this reduction in usable habitat would lead to increased browse use levels that would result in plant mortality. A 10-year clipping trial study conducted by Colorado State University indicated that repeated plant removal above 60 percent resulted in increased plant mortality of big sagebrush. Displacement of animals, due

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

to project-related activities onto either of these ranges for a longer time period would increase overall browse use levels on both transition and crucial winter range above 60 percent, which would result in plant mortality, lower vigor, and declining cover of remaining Wyoming big sagebrush plants.

Pronghorn Antelope

The 42,900 acres of pronghorn crucial winter/yearlong range are located along the western edge of the ARPA (map M-21). Approximately 43.5 percent (BLM GIS calculation) of the crucial winter/yearlong range in the Baggs pronghorn herd unit is within the ARPA. The remainder of the ARPA is classified as winter/yearlong or spring/summer/fall range.

Standard mitigations prohibiting construction, drilling, and other activities potentially disruptive to pronghorn within crucial winter range from November 15 to April 30 would reduce the probability of displacement during this critical time of the year. During the production phase, there is no equivalent mitigation and animals may be displaced up to 0.25 miles from the source (USDI-BLM 2004c). This would lead to increased stress/decreased condition or reproductive rates of the animals as they travel farther and may have to use lower-quality range. To reduce human presence, remote monitoring of project facilities would be used to the greatest extent possible during the production phase.

Several general pronghorn migration routes transverse the ARPA; it is unknown how critical these routes are. This project could alter or block pronghorn movements along existing migration routes.

In addition to the direct removal of habitat due to the development of pads and associated ancillary facilities, disturbances from drilling activities and traffic would affect use of the habitat adjacent to these areas. However, pronghorn have been found to habituate to increased traffic volumes and heavy machinery as long as the machines move in a predictable manner (Reeve 1984). Well development operations and deviation from ordinary activities may cause antelope displacement of up to 0.625 miles (Easterly et al. 1991), but they would likely habituate to activities along roads and continue using habitats in those areas (Reeve 1984). The magnitude of displacement would decrease over time as (1) the animals have more time to adjust to the circumstance and (2) the extent of the most intensive activities such as drilling and road building diminishes and more wells are put into production. By the time the field is under full production, construction activities would have ceased, and traffic and human activities would be reduced.

The perception of pronghorn use in and near oil and gas development projects is that some individuals may habituate to project construction and operational activities in both the short and long term. Over time, some individuals may habituate to certain disturbances, depending on the spatial relationship (i.e., distance) between these areas of disturbance to available forage, water, and thermal cover. However, this is true for only certain individuals within a population. Other individuals may exhibit a lower tolerance to human-related activity. Therefore, animals within a population may respond differently to construction and operational activity. BLM RFO biologists have noted anecdotally that antelope herd sizes are significantly smaller in impacted areas than in relatively pristine areas. Those animals that potentially acclimate seem to do so only in smaller herd sizes. In undisturbed areas, the herds are much larger and show flight responses at much greater distances than in disturbed zones. Minimizing human presence at well sites after they have been put into production and timely reclamation of well pads, pipelines, and ROWs would help reduce displacement of pronghorn from the well field.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

However, fences along Highway 789 create a migration barrier not allowing pronghorn to move from east to west across the highway. Pronghorn found east of this highway are restricted to crucial winter habitat found along Muddy Creek and against Highway 789, creating a trap to animal movement. The State of Wyoming has constructed a section of lay-down fence, unrelated to the ARPA, to help reduce this effect.

Mule Deer

The 74,492 acres of mule deer crucial winter and crucial winter/yearlong range are located within the ARPA (map M-23). Approximately 27 percent of the crucial winter and crucial winter/yearlong range in the Baggs mule deer herd unit is within the ARPA. Forty-two percent of this crucial winter range is on private and state land and is afforded no protection (section 3.7.2.2). Therefore, loss of this crucial winter range is likely during the life of project leading to increased use on public land crucial winter range. Construction activities remove crucial winter range vegetation and increase noise and human activity levels which displaces animals. The critical shrub component removed within crucial winter range would not be replaced (with potentially the exception of mountain sagebrush) to pre-development levels during the life of the project.

Prohibiting construction, drilling, and other activities potentially disruptive to mule deer within crucial winter range from November 15 to April 30 would reduce the probability of displacement during this critical time of the year. During the production phase, there is no equivalent mitigation and animals may be displaced up 0.75 miles from the source (USDI-BLM 2004c). This would lead to increased stress/decreased condition or reproductive rates of the animals as they travel farther and may have to use lower quality range. To reduce human presence, remote monitoring of project facilities would be used to the greatest extent possible during the production phase.

Several mule deer migration routes transverse the ARPA. A research project initiated by the BLM and WGFD in February 2005, funded by two of the operators, should help delineate the migration routes used by mule deer on the ARPA. When information is available from this research, additional mitigation would be placed on development for the protection of mule deer migration corridors. Meanwhile, this project could alter or block mule deer movements along existing migration routes.

In addition to the direct removal of habitat due to the development of pads and associated ancillary facilities, disturbances from drilling activities and traffic would affect the use of the habitat immediately adjacent to these areas. Mule deer, however, are adaptable and may adjust to non-threatening, predictable human activity (Irby et al. 1988 and Gusey 1986). However, the Sublette Mule Deer Study, which used Global Positioning System (GPS) collars, found that winter mule deer habitat selection and distribution patterns have been affected by development, specifically road networks and well pads. Sawyer found no evidence of acclimation behavior. During 3 years of study, mule deer had higher probability of use in areas farther away from well pads as development progressed. Predictive maps also suggest that some habitats considered "high probability of use" areas prior to development, changed to "low probability of use" areas as development progressed, and visa versa.

Indirect habitat loss can be substantially greater than the direct loss of habitat to roads and well pad construction. Reduction in winter range size and quality of available habitat may decrease the carrying capacity of the overall winter range (Sawyer et al. 2004). This suggests that within the ARPA, indirect impacts such as displacement from activities, dust from roads, and

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

competition for forage within the already poor condition crucial winter range habitat may lead to reduced mule deer numbers and die-offs from animals going onto crucial winter range in poorer health with reduced body reserves.

Elk

Approximately 41,000 acres or 20 percent of the crucial winter/yearlong range in the Sierra Madre elk herd unit is within the ARPA (map M-24). Several elk migration routes transverse the ARPA; however, it is unknown how critical these routes are. This project could alter or block elk movement along existing migration routes.

Construction activities remove crucial winter range vegetation and increase noise and human activity levels which displace animals. However, much of the crucial winter range is on steeper south- and west-facing slopes that would be avoided during development. The amount of vegetation disturbed is not as important as the noise and activity levels that would still occur and result in displacement of elk. In addition to the direct removal of habitat due to the development of pads and associated transportation facilities, disturbances from drilling activities and traffic would affect use of the habitat adjacent to these areas (Powell 2003). Elk are more sensitive to human activities than pronghorn or mule deer, and they may be displaced in construction areas from 0.6 to 1.2 miles for elk depending upon the season (Powell 2003). Displacement would be reduced in areas with topographic barriers (Edge and Marcum 1991). Elk would likely habituate to the physical presence of gas wells (Ward et al. 1973, Ward 1976, Hiatt and Baker 1981, Perry and Overly 1976). However, elk rarely adjust to continued human presence required during the production phase of the project (Thomas and Toweill 1982). With the increase in roads and potential recreational access to the area, displacement of elk is extremely likely during all phases of development. During the production phase, there is no equivalent mitigation and animals may be displaced up to 1 mile from the source (USDI-BLM 2004c). This would lead to increased stress/decreased condition or reproductive rates of the animals as they travel farther and may have to use lower-quality range. To reduce human presence, remote monitoring of project facilities would be used to the greatest extent possible during the production phase.

Overlapping Big Game Crucial Winter Range

Areas of overlapping big game crucial winter range are of greater importance because they provide crucial habitat for more than one species of big game. There are several areas of overlapping big game crucial winter range located within the ARPA (map M-25). The combinations of overlapping big game crucial winter range include the following: elk/mule deer, 3,038 acres and mule deer/antelope, 22,637 acres. Forty percent of this habitat is on private and state lands where there are no protections against disturbance of animals during crucial time periods.

Indirectly, this may increase inter- and intra-species competition for forage and thermal cover; in areas already at carrying capacity, density-dependant species would be further displaced. This may force animals to use lower-quality habitats, which may lead to a reduction in reproductive rates or an increase in predation.

Upland Game Birds

Greater Sage-Grouse. Greater sage-grouse are abundant within the ARPA, due to the high amount and diversity of suitable habitat, lack of habitat fragmentation, and the close proximity of upland and riparian habitats. In addition, all habitats needed to fulfill the life history requirements of this species are found adjacent to one another. Potential impacts to greater

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

sage-grouse include loss of nesting or early brood-rearing habitat, decreased population productivity caused by loss of nesting or early brood-rearing habitat, reduced utilization of suitable habitats due to indirect disturbance, loss of winter habitat, increased predation due to increased roosting sites for raptors on power poles and other structures, and displacement of birds into lower quality habitats.

Potential sources of direct impacts to greater sage-grouse include excessive noise levels proximal to occupied leks; disruptive human activities that occur during the daily time period in which courtship and breeding, nesting, brood-rearing, and foraging activities take place; and habitat loss from construction of project facilities. Noise levels interfere with bird communication during mating periods resulting in lower bird attendance at leks. Disruptive human activities alter normal bird behavior, increase nest abandonment, and may displace birds into less-desirable habitats. Construction of facilities and roads creates a long-term loss of greater sage-grouse habitat, increases fragmentation of remaining habitat. Increased predation due to facilities, such as well houses, compressor stations, and aboveground power lines serving as perches for raptors and corvid's can result in long term loss. Roads may also serve as travel corridors for some predators, such as foxes and coyotes. All of these impacts lead to lower productivity and long-term decline in the population of this species.

Of greater concern is the indirect loss of habitat resulting in bird displacement and fragmentation of nesting and early brood-rearing habitat. Sources of indirect impact primarily relate to dust settling on vegetation and loss of sagebrush habitat due to over-browsing by antelope and mule deer. Dust reduces the palatability and production of forbs and shrubs used by grouse. Over-browsing by big game on ranges shared with grouse would reduce quality and abundance of nesting, brood-rearing, winter habitats, and forage.

Potential greater sage-grouse nesting habitat covers 92 percent of the ARPA. In the long-term, recovery of shrubs to pre-disturbance levels would not occur during the life of the project. Therefore, there would be a long-term loss of nesting habitat.

Sage-grouse may repopulate an area following energy development, but may not attain population levels that occurred before development (Braun 1998). Most nests abandoned are directly or indirectly related to human activity. Likelihood of abandonment is higher when nests are disturbed early in the incubation period (Remington and Braun 1991).

Naugle et al. (2006) found that leks along the edge of CBNG development had higher lek attendance than leks within the developed area. The hypothesis that sage-grouse avoid developed areas is supported by the finding that active leks and leks with moderate to large numbers of males were often found adjacent to CBNG fields but rarely within CBNG. In contrast, inactive leks and leks with few males were often found within CBNG fields. One of the most striking patterns discovered was that, of leks counted in either 2004 or 2005, no medium or large-sized leks occurred within CBNG development; all remaining leks in CBNG have 20 or fewer males. Summary statistics for well and power line variables calculated from GIS layers around active and inactive leks indicate that active leks typically are twice as far from wells, one-half times as far from power lines, have one-third the density of wells, one-half the density of power lines, and generally have less development (wells and power lines) within 3.2 kilometers (km) of the lek complex. In addition, a significantly higher proportion of lek complexes are inactive in CBNG areas compared to areas on the edge of or outside CBNG (excluding lek complexes of unknown status and those destroyed by agriculture or mining).

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Columbian Sharp-Tailed Grouse. Six occupied Columbian sharp-tailed grouse lek locations have been documented on or within 1 mile of the ARPA, which comprises 27 percent of the leks within the BLM RFO land management area (map M-27). Potential Columbian sharp-tailed grouse nesting habitat (habitat located within 1 mile of an occupied lek) covers 4,956 acres or 1.8 percent of the ARPA (section 3.7.3.2). Leks are not located on BLM lands; however, 785 acres of nesting and brood-rearing habitat are located on BLM lands. These leks represent the northernmost extent of the known distribution of Columbian sharp-tailed grouse, and may represent 27 percent of the leks known to occur in Wyoming. Wintering habitat for sharp-tailed grouse (serviceberry/mixed mountain shrub habitat) totals 287 acres, of which 278 acres are on BLM land.

Potential sources of impact to sharp-tailed grouse include excessive noise levels proximal to occupied leks, and disruptive human activities that occur during the daily time period in which courtship and breeding activities take place. As no leks are located on BLM-managed lands, the potential for disturbance during courtship and breeding periods is likely as there are no timing restrictions for surface disturbing or other disruptive activities. Also, in the long-term, recovery of shrubs to pre-disturbance levels would not occur during the life of the project for sharp-tailed grouse nesting and brood-rearing habitat.

The application of avoidance and mitigation measures on BLM lands would help to reduce stress to sharp-tailed grouse during nesting and brood-rearing periods. There are no measures to protect the habitat from being removed by project activities outside this spring period on BLM lands or at any time on private and state lands.

Wintering Areas for Grouse. Wintering areas (as they are mapped) would be protected from surface disturbing activities from November 15 to March 14. Activities would be allowed outside this timing period and habitat could be removed. This would result in habitat loss as well as potential displacement of wintering birds.

Approximately 200 acres of severe winter relief areas (SWR), of which 174 acres are on BLM land, have been identified and mapped so far. Mapped wintering habitat for sharp-tailed grouse (serviceberry/mixed mountain shrub habitat) totals 287 acres, of which 278 acres (97 percent) are on BLM land. Surface-disturbing activities would be prohibited in serviceberry/mixed mountain shrub habitat and SWR, which would also protect this wintering habitat for grouse.

Raptors

The potential impacts that the project could have on raptors include nest abandonment and reproductive failure due to project activities or increased human disturbance, reductions in prey populations, mortality from vehicle collisions, loss of nesting habitat, decreased population recruitment, and reduced use of suitable habitats.

There are 357 raptor nests located within the ARPA, with an additional 185 raptor nests within 1 mile of the ARPA boundary (1 mile seasonal protection) totaling 542 nests. The total acreage around nests, buffered by 1 mile of seasonal protection, totals 173,483 acres or 64 percent of the ARPA.

Development of the project would disturb habitat for several prey species. The amount of short-term change in prey base populations created by construction is expected to be minimal in comparison to the overall level of small mammal populations. While prey populations on the project area would likely sustain some reduction during the development phase of the project,

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

most prey species would be expected to rebound to pre-disturbance levels following initial reclamation. Once reclaimed, these areas would likely promote an increased density and biomass of small mammals that is comparable to those of undisturbed areas (Hingtgen and Clark 1984). For these reasons, no measurable long-term reductions are anticipated to the prey base. However, prey populations may be displaced due to dust and habitat loss. In turn, those raptors (i.e., prairie falcon and burrowing owl) dependant on small birds and insects may be indirectly affected.

Some raptors feed on carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed. The potential for such collisions can be reduced by requiring that drivers undergo training that describes the circumstances under which vehicular collisions are likely to occur and measures that can be taken to minimize them.

Fish

Refer to section 4.8 for impacts to sensitive fish species.

4.7.3.2 Proposed Action

Development would alter or remove approximately 15,800 acres of wildlife habitat over the next 20 years. However, reclamation of disturbed habitats would commence immediately and continue throughout the 20-year construction period, resulting in a short-term recovery of grass-dominated habitat. This reclamation would reduce the area disturbed by 60 percent down to 6,240 acres. Long-term recovery of shrubs to pre-disturbance levels would not occur during the life of the project. On average, there would be 63.2 acres of pre- and 24.8 acres of post-reclamation disturbance with the maximum eight pad locations per section.

Impacts are the same as identified in section 4.7.3.1 above, except as discussed below.

General Wildlife (Species Other than Those Described in Sections below)

The long-term disturbance would have a minor effect on wildlife species not dependant upon shrubs. Impacts to songbirds that are dependant upon shrub habitats for nesting and foraging would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project (as discussed in section 4.7.3.1, General Wildlife), would exceed the significance criteria (criteria numbers 3 and 4).

Big Game

Pronghorn Antelope. The acreage disturbance and the actual number of pads per section would fall under a high impact post-reclamation. The direct loss/reduced usability of Wyoming big sagebrush would increase use on remaining shrubs, resulting in shrub health decline outside the immediate project disturbances. This would have the greatest impact to antelope due to their extreme reliance upon sagebrush (96 percent of their diet) during winter. This level of development within pronghorn crucial winter range, compounded by the current condition of the crucial winter habitat would exceed the significance criteria (criterion number 3).

Mule Deer. The acreage disturbance and the actual number of pads per section would fall under a high impact post-reclamation. This level of development within mule deer transitional

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

range and crucial winter range, compounded by the current poor condition of the crucial winter habitat, would exceed the significance criteria (criterion number 3).

Elk. Although actual acreage disturbance would fall under a “high” impact post-reclamation, there would be an “extreme” impact to elk based on the actual number of pads (eight pads per section) (WGFD 2004c). With this level of development, impacts to elk crucial winter range would exceed the significance criteria (criterion number 3).

Upland Game Birds

Greater Sage-Grouse. Proposed Action habitat disturbances would equate to a maximum direct loss of 10 percent of the available nesting habitat (eight locations per section with associated roads and facilities). However, the acreage disturbed by this alternative would fall into the high impact category (WGFD 2004c).

Of greater concern is the indirect loss of habitat resulting in bird displacement and fragmentation of nesting and early brood-rearing habitat. At eight locations per section impact zones surrounding each well pad, facility and road corridor begin to overlap, thereby reducing habitat effectiveness over much larger, contiguous areas. Human, equipment, and vehicular activity and noise impacts are also more frequent and intensive (WGFD 2004c).

The application of avoidance and mitigation measures would help reduce the loss of habitat and stress to greater sage-grouse in proximity to leks on public lands. Based on research conducted in Wyoming, only 45 percent of nests would be afforded seasonal protection as they are within the 2-mile buffer of leks. Of the suitable nesting habitat, 21 percent is outside the 2-mile buffer and would be afforded no seasonal protection. Habitat loss would continue outside the quarter-mile-protected buffer around leks. However, the long-term loss of shrubs combined with the indirect impacts on the habitat, such as dust, noise, and continued human presence during the drilling and production phase, would result in habitat loss and disturbance levels exceeding the significance criteria (criterion number 4).

Columbian Sharp-Tailed Grouse. The application of avoidance and mitigation measures in this alternative would help to reduce stress to nesting and brood-rearing and wintering sharp-tailed grouse. However, because of the magnitude of habitat loss and continued human presence during the production phase of the project, impacts would exceed the significance criteria (criterion number 4).

Wintering Areas for Grouse. The timing stipulation prevents winter disturbance to greater sage-grouse, but does not prevent the direct loss of wintering areas outside of this time period. Loss of this habitat would lead to lower productivity and long-term decline in the population of these species.

Raptors

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria.

Fish

Refer to section 4.8 for impacts to sensitive fish species.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.7.3.3 Alternative A (No Action)

Under Alternative A, drilling would continue for the approved Atlantic Rim pod EAs until they are completed. The remainder of the area would remain undeveloped.

4.7.3.4 Alternative C

Alternative C would proceed with development across the ARPA similar to the Proposed Action alternative, but would be constrained by crucial/sensitive resource concerns. These sites would have additional protective measures beyond what is already provided by applying standard mitigation stipulations (appendix E, appendix H, and appendix L). Examples of these sensitive sites are steep slopes, soils with high runoff potential, big game crucial winter range, and greater sage-grouse nesting and brood-rearing habitat. Because of these sensitive issues, there would be less surface disturbance allowed per section on BLM lands. This would reduce the surface disturbance on lands administered by the BLM by approximately 68 percent relative to the Proposed Action. There would be less than 20 acres of pre-reclamation and 5 acres of post-reclamation surface disturbance with a maximum of four pads per section in grouse nesting and brood-rearing habitat and crucial winter range on BLM lands. This would reduce impacts on different wildlife species to varying degrees.

The overall reduction in acres initially disturbed would reduce habitat fragmentation and indirectly increase potential recruitment of native species re-establishing disturbed sites. This would decrease the overall habitat loss and displacement effects to wildlife species, as well as reduce impediments within movement corridors. A reduction in disturbance of wildlife habitat on BLM lands by 68 percent would benefit all species and reduce the time required, long term, to return the functionality of the habitat in the project area. These benefits would be realized to the greatest extent in the central and southern portions where there is a preponderance of BLM lands. The extreme southern portion and the northern half would realize some benefit of these additional mitigations, but their effectiveness would be reduced due to the lack of equivalent mitigation on private and state lands.

General Wildlife (Species Other than Those Described in Sections below)

Under this alternative, additional mitigation would be applied to minimize impacts to important crucial winter range, important winter habitat for grouse, and greater sage-grouse nesting and brood-rearing habitats. This mitigation to reduce total acres of disturbance would directly and indirectly benefit small birds and mammals. This would reduce disturbance in essential habitats during critical time periods for a diversity of wildlife species. This can include, but is not limited to nesting, brood-rearing, thermal cover and transitional habitat use for a diversity of small birds and mammals. Due to these factors, impacts would not exceed the significance criteria for small mammals and songbirds.

Big Game

Although the exact locations are unknown, at least initially the placement of pads, roads, and other facilities within the ARPA would be focused on areas that are on and adjacent to the existing pods. As build-out occurs from the pods, the unaffected extent of big game crucial winter range acreage would be reduced. Below are the calculations of the percentage of crucial winter range to be impacted (by species of big game) and what percent of the project area would be affected by the additional mitigation. This does not take in to account the impacts to transitional range or migration corridors.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

The following acreage figures are for direct habitat loss (conversion of habitat to pads, roads, compressor stations, etc.). There would be less than 20 acres of pre-reclamation and 5 acres of post-reclamation disturbance with the maximum four pads per section (resource roads and pads, not collector roads) on BLM lands within crucial winter range.

Pronghorn Antelope

The pronghorn herd units to be affected by the ARPA are the Bitter Creek and Baggs units. Out of 99,574 acres of crucial winter range habitat found within the Bitter Creek unit, 1,400 acres are located within the ARPA (1 percent). Out of 95,557 acres of crucial winter range habitat found within the Baggs unit, 41,500 acres are located within the ARPA (43 percent). As noted in section 4.7.3.1 (under Big Game), a total of 42,900 acres of pronghorn crucial winter range is located within the ARPA. Twenty-four percent of the crucial winter range is on private and state lands; additional mitigation would not be applied to those lands. Additional mitigation would occur on approximately 12 percent of the ARPA. Reduced acreage of habitat loss within crucial winter range would not help the downward trend in the health of crucial winter range.

Mule Deer

The mule deer herd unit to be affected by the ARPA is the Baggs unit. Out of 270,893 acres of crucial winter range habitat found within the unit, 73,270 acres are located within the ARPA (27 percent). Forty-two percent of the crucial winter range is on private and state lands; additional mitigation would not be applied to those lands. Additional mitigation would occur on approximately 16 percent of the ARPA. Reduced impacts to transition range would help maintain the health of crucial winter range.

Elk

The elk herd units to be affected by the ARPA are the Petition and Sierra Madre units. No crucial winter range for the Petition unit is found within the ARPA. Out of 178,697 acres of crucial winter range habitat found within the Sierra Madre unit, 40,840 acres are located within the ARPA (23 percent). Elk crucial winter range additional mitigation would be applied to approximately 15 percent of the ARPA. Fifteen percent of the crucial winter range is on private and state lands; additional mitigation would not be applied to those lands. Additional mitigation would occur on approximately 10 percent of the ARPA.

Under this alternative, the direct acreage disturbance and number of pads would result in significant impacts to pronghorn and mule deer crucial winter range. For elk crucial winter range, impacts would be reduced to the high category, which would still exceed the significance criteria (criterion number 3).

Upland Game Birds

There would be less than 20 acres of pre-reclamation and 5 acres of post-reclamation with the maximum four pads per section (resource roads and pads, not collector roads) within nesting and brood-rearing habitat.

Greater Sage-Grouse. Ninety-two percent of the project area contains brood-rearing and nesting habitat for greater sage-grouse (BLM-estimated by applying a 2-mile radius buffer around known sage-grouse leks). Direct disturbance would be reduced by 68 percent on public lands, reducing long-term loss of greater sage-grouse habitat to the moderate category. Short-term suspension of grazing use in some pastures would leave more residual grass cover and forbs on grouse habitat, which in turn would benefit those grouse nesting and brood-rearing in

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

these localized areas. However, the indirect impacts (displacement from construction and drilling noise, traffic, increased human activity) would still exceed the significance criteria (criterion number 4).

Columbian Sharp-Tailed Grouse. Columbian sharp-tailed grouse are found within the southern half of the ARPA. Soil mitigation, restricting surface disturbance on high runoff potential soils, would also indirectly protect nesting and brood-rearing habitat (4,956 acres located in the ARPA). Direct disturbance would be reduced by 68 percent on the 785 acres of nesting and brood-rearing habitat located on BLM lands (16 percent) of nesting and brood-rearing habitat located on BLM lands, reducing direct impacts to the moderate category (section 4.7.3.1, Upland Game Birds, specifically Columbian Sharp-tailed grouse). Disturbance could be the same or greater on the 4,171 acres (84 percent) of nesting and brood-rearing habitat located on private and state land, maintaining impacts in the high category. This combined with other indirect impacts would still exceed the significance criteria (criterion number 4).

Raptors

Under this alternative, impacts would be reduced by minimizing the amount of surface disturbance within sensitive/critical resource areas. With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria.

4.7.3.5 Alternative D

Development would alter or remove approximately 13,600 acres (13,000 new acres and 600 existing acres of disturbance) of wildlife habitat over the next 20 years. At any one time, total unreclaimed disturbance would be capped at 2.8 percent of the entire ARPA or 7,600 acres. Those areas designated as "Category A" would be managed more intensively (utilizing appropriate lease stipulations, conditions of approval, and best management practices) to reduce the extent of surface disturbance below an average of 6.5 acres of disturbance per well constructed. A description of "Category A" areas can be found in section 2.1.4 Alternative D. Reclamation of disturbed habitats would commence immediately after completion of site disturbance activities and continue throughout the 20-year construction period, resulting in a short-term recovery of grass-dominated habitat. Long-term recovery of shrubs to pre-disturbance levels would not occur during the life of the project. On average, there would be 52 acres of pre- and 20 acres of post-reclamation disturbance with the maximum eight pad locations per section.

Impacts are the same as identified in section 4.7.3.1 above, unless discussed below.

General Wildlife (Species Other than Those Described in Sections below)

The long-term disturbance would have a minor effect on wildlife species not dependant upon shrubs. Impacts to songbirds that are dependant upon shrub habitats for nesting and foraging would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria (criterion number 4).

Big Game

Pronghorn Antelope. The acreage disturbance and the actual number of pads per section would fall under a high impact post-reclamation. The direct loss/reduced usability of Wyoming big sagebrush would increase use on remaining shrubs, resulting in continued shrub health

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

decline outside the immediate project disturbances. This would have the greatest impact to antelope due to their extreme reliance upon sagebrush (96 percent of their diet) during winter. This level of development within pronghorn crucial winter range, compounded by the current condition of the crucial winter habitat, would exceed the significance criteria (criterion number 3).

Mule Deer. The acreage disturbance and the actual number of pads per section would fall under a high impact post-reclamation classification. This level of development within mule deer transitional range and crucial winter range, compounded by the current poor condition of the crucial winter habitat, would exceed the significance criteria (criterion number 3).

Elk. Although actual acreage disturbance would fall under a high impact post-reclamation, there would be an extreme impact to elk based on the actual number of pads (eight pads per section) (WGFD 2004c). With this level of development, impacts to elk crucial winter range would exceed the significance criteria (criterion number 3).

Upland Game Birds

Greater Sage-Grouse. Alternative D habitat disturbances would equate to a maximum direct loss of 8.1 percent of the available nesting habitat (eight locations per section with associated roads and facilities). Under this alternative there is a goal of 20 percent reduction of such habitat disturbance. The extent acreage disturbed by this alternative would place it into the high impact category.

Of greater concern is the indirect loss of habitat resulting from bird displacement and fragmentation of nesting and early brood-rearing habitat. At eight locations per section, impact zones surrounding each well pad, facility, and road corridor begin to overlap, thereby reducing habitat effectiveness over much larger, contiguous areas. Human, equipment, and vehicular activity and noise impacts are also more frequent and intensive at this level of development (WGFD 2004c).

The application of avoidance and mitigation measures would help reduce the loss of habitat and stress to greater sage-grouse in proximity to leks on public lands. Based on research conducted in Wyoming, only 45 percent of nests would be afforded seasonal protection as they are within the 2-mile buffer of leks. Of the suitable nesting habitat, 21 percent is outside the 2-mile buffer and would be afforded no seasonal protection. Habitat loss would continue outside the quarter-mile-protected buffer around leks. However, the long-term loss of shrubs combined with the indirect impacts on the habitat, such as dust, noise, and continued human presence during the drilling and production phase, would result in habitat loss and disturbance levels exceeding the significance criteria (criterion number 4).

Columbian Sharp-Tailed Grouse. The application of avoidance and mitigation measures in this alternative would help to reduce stress to nesting and brood-rearing and wintering sharp-tailed grouse. However, because of the magnitude of habitat loss and continued human presence during the production phase of the project, impacts would exceed the significance criteria (criterion number 4).

Raptors

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Fish

Refer to section 4.8.3.2 for impacts to sensitive fish species.

4.7.4 Impacts Summary

4.7.4.1 Proposed Action

Standard mitigation measures would indirectly help songbirds during critical time periods; however, impacts on nesting and foraging habitats would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria (criteria numbers 3 and 4).

The impact to small mammals is likely to be minor, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area following interim reclamation. Most of these species would benefit from an increase in grass-dominated vegetation from reclamation.

This level of development within big game crucial winter and transition ranges, compounded by the current condition of these ranges, would exceed the significance criteria (criterion number 3).

The application of the winter timing stipulation would only protect grouse during this crucial time period. This does not prevent the direct loss of wintering areas for grouse outside of this time period. The long-term loss of shrubs combined with the indirect impacts on the habitat, such as dust, noise, and continued human presence during the drilling and production phases, would result in the proposed action activities exceeding the significance criteria for greater sage-grouse (criterion number 4).

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria for raptors.

4.7.4.2 Alternative C

Impacts would not exceed the significance criteria for small mammals and songbirds due to these animals' mobility and the additional mitigation measures included under this alternative. These measures would reduce the long term loss of shrubs, the indirect impacts on habitat, such as dust, noise, and continued human presence during the drilling and production phases. This mitigation would directly and indirectly benefit small birds and mammals by reducing disturbance in essential habitats during critical time periods.

Direct and indirect impacts to pronghorn crucial winter range would exceed the significance criteria. Direct impacts to mule deer crucial winter range, combined with indirect impacts, would still exceed the significance criteria. For elk crucial winter range, impacts would be reduced to the high category, which would still exceed the significance criteria (criterion number 3).

Long-term loss of habitat to greater sage-grouse and Columbian sharp-tailed grouse, combined with indirect impacts (See section 4.7.3.1 above) would still exceed the significance criteria (criterion number 4).

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria for raptors.

4.7.4.3 Alternative D

Standard mitigation measures would indirectly help songbirds during critical time periods; however, impacts on nesting and foraging habitats would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria (criteria numbers 3 and 4).

The impact to small mammals is likely to be minor, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area following interim reclamation. Most of these species would benefit from an increase in grass-dominated vegetation from reclamation.

This level of development within big game crucial winter and transition range, compounded by the current condition of these ranges, would exceed the significance criteria (criterion number 3).

The application of the winter timing stipulation would only protect grouse during this critical time period. This does not prevent the direct loss of wintering areas for grouse outside of this time period. The long-term loss of shrubs combined with the indirect impacts on the habitat, such as dust, noise, and continued human presence during the drilling and production phases would result in the Proposed Action activities exceeding the significance criteria for greater sage-grouse (criterion number 4).

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria for raptors.

4.7.5 Additional Mitigation Measures

There are no additional measures proposed for the Proposed Action, Alternatives A and D. For Alternative C, additional mitigation measures are proposed over and above the requirements in appendices E, B, H, and J, and can be found as the development protection measures in appendix L. Alternative D emphasizes reduced disturbance and monitors successful reclamation, putting a limit on disturbance if unreclaimed areas exceed 2.8 percent, or 7,600 acres, of the ARPA. A goal of even further reduced disturbance is placed on Category A (map M-7) areas. Those areas designated as "Category A" would be managed more intensively (utilizing appropriate lease stipulations, conditions of approval, and best management practices) to reduce the extent of surface disturbance below an average of 6.5 acres per well constructed. A description of "Category A" areas can be found in section 2.1.4 Alternative D.

The Proposed Action and Alternative D require that the operators submit annual planning reports to the BLM for their plan of operation for the upcoming year. The BLM will work with the operators at a site-specific level to minimize surface disturbance by applying appropriate lease stipulations, conditions of approval, BMPs and any other measures deemed necessary to minimize surface disturbance and still allow for the maximum economic recovery of natural gas.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.8 Special Status Plant, Wildlife, and Fish Species

4.8.1 Introduction

The USFWS has determined that nine species, which are listed under the ESA as either threatened, endangered, proposed or candidate species, are potentially present within the BLM RFO management area (USDI-FWS 2004 and table 3-34). In addition, ten species found downstream of the BLM RFO management area in the Platte and Colorado River systems may potentially be impacted if water depletions occur. More detailed information on threatened, endangered, and proposed species is presented in the biological assessment for the Atlantic Rim Project (appendix G). A total of 36 species (7 plants, 6 mammals, 16 birds, 3 amphibians, and 4 fish) occur on the BLM Sensitive Species List in the RFO management area and may occur on or near the ARPA.

4.8.2 Impact Significance Criteria

The Great Divide RMP management objectives for special status wildlife and fish species are the same as presented for wildlife in section 4.7.2. The following criteria were considered in the assessment of impacts associated with the Proposed Action and the alternatives and are the same as those contained in the draft Rawlins RMP (USDI-BLM 2004c). Impacts to species of special concern including threatened, endangered, proposed, candidate, and sensitive species would be considered significant if any of the following was to occur:

1. Substantial loss of habitat function or disruption of life history requirements of a species or population segment that would make them eligible for listing under the ESA.
2. Decreased viability or increased mortality of threatened and endangered, proposed and candidate species, or reduction or alteration of their critical habitats.
3. Management actions that result in substantial disruption or irreplaceable loss of vital and high value habitats, as defined in the WGFD (2004c) Mitigation Policy.
4. Substantial loss of habitat function or disruption of life history requirements of special status species that would preclude improvement of their status.
5. Actions preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species.

4.8.3 Direct and Indirect Impacts

4.8.3.1 Direct and Indirect Impacts Common to All Alternatives

The Wildlife Monitoring and Protection Plan (appendix E) would be followed to prevent, reduce, and detect impacts to threatened, endangered, proposed, and candidate wildlife and fish species throughout the life of the project. The Wildlife Monitoring and Protection Plan serves two purposes. One is to describe the protocols to monitor wildlife responses, habitats, behavioral shifts, etc. The other is to provide protocols to protect wildlife species and track the effectiveness of these protections.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Wildlife habitats directly affected by the proposed project include areas that are physically disturbed by the construction of wells, roads, pipelines, and production facilities. Wildlife habitats indirectly impacted might not be physically disturbed, but the suitability of these habitats is affected by direct disturbances in nearby areas. Disturbance during construction and production phases of development, such as human presence, dust, and noise, may displace or preclude wildlife use of disturbed areas. Wildlife sensitivity to these impacts varies considerably with each animal species.

4.8.3.2 Proposed Action

The following threatened and endangered, proposed, or candidate species are not known to exist in the ARPA and would not be impacted by the project: Blowout penstemon, Colorado butterfly plant, Ute Ladies'-tresses, Canada lynx, Preble's meadow jumping mouse, yellow-billed cuckoo, whooping crane, interior least tern, piping plover, and Eskimo curlew, and Wyoming toad. In addition, there would be no water depletions in the North Platte Drainage so there would be no impacts to the western prairie fringed orchid. Species which may be affected, as well as fish species, are discussed below.

Threatened and Endangered Wildlife Species

Black-Footed Ferret. Development of the Proposed Action would likely result in direct disturbance of some portions of the black-footed ferret's prey, prairie dogs. Surveys for black-footed ferrets would be required before ground disturbing activities within prairie dog colonies located in the Dad Complex. The remaining white-tailed prairie dog colonies within the ARPA are in the "block clearance" area, where surveys for black-footed ferrets are no longer warranted. Implementation of the Proposed Action may affect but is not likely to adversely affect the black-footed ferret.

Bald Eagle. Bald eagles have been observed within the project area primarily during December, January, and February (WGFD 2003a). The majority of bald eagle sightings are in the southern portion of the ARPA close to the Little Snake River. Bald eagles may use the project area for foraging during winter months because a large portion of the project area consists of winter range for antelope, mule deer, and elk.

The potential for vehicle-animal collisions would increase as a result of increased vehicular traffic associated with the project. Because bald eagles commonly feed on carrion, particularly during the winter months, the presence of road-killed wildlife on and adjacent to the access roads is an attractant. Eagles feeding on these carcasses are in danger of being struck by moving vehicles. Any increase in the death rate of bald eagles from vehicular collisions would constitute a significant impact. Because the potential for an increase in wildlife-vehicle-eagle encounters exists, the bald eagle may be affected, but is not likely to be adversely affected.

Threatened and Endangered Fish Species

Four federally endangered fish species may occur as downstream residents of the Colorado River system: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USDI-FWS 2003). One federally endangered fish species, the pallid sturgeon (*Scaphirhynchus albus*), may occur as a downstream resident of the Platte River system in Nebraska.

Though they currently exist only downstream of the ARPA, water draining from the ARPA affects the downstream habitat for these species. Under the Upper Colorado River Basin

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Endangered Fish Recovery Program “any water depletions from tributary waters within the Colorado River drainage are considered as jeopardizing the continued existence of these fish.” Tributary water is defined as water that contributes to instream flow habitat. Depletion is defined as water that would contribute to the river flow if not intercepted and removed from the system. The BLM retains discretionary authority over individual projects within the project area for the purpose of endangered species consultation. If the recovery program is unable to implement the Recovery Implementation Plan (RIP) in a timely manner or make sufficient progress in recovery of these endangered species, re-initiation of ESA section 7 consultation may be required so that new reasonable and prudent alternatives can be developed. The USFWS has determined that progress made under the RIP has been sufficient to merit a waiver of the mitigation fee for depletions of 100 acre-feet per year or less (USDI-FWS 1995). The Proposed Action would deplete approximately 10.3 acre-feet of water per year, and thus a mitigation fee waiver would be applicable.

Under the Proposed Action, the primary source of potential risks to these fish species is increases in suspended sediments and sedimentation from land disturbance from project activities. No produced water from the ARPA would be discharged to the Little Snake River drainage; therefore, produced water discharges do not pose a risk to these species. Accidental releases of produced waters or other materials could occur. However, these materials would become highly diluted before they would reach any downstream waters where these species occur; consequently, the potential risks from such occurrences are negligible.

Colorado Pikeminnow, Bonytail, Humpback Chub, and Razorback Sucker. Suitable habitat for these species does not exist on the ARPA. Suitable habitat does exist downstream of the ARPA in the Yampa and Green Rivers; however, the Proposed Action is not expected to affect this habitat provided that mitigation measures for water resources and soils outlined in this document are implemented.

Pallid Sturgeon. Suitable habitat for this species is not available on the ARPA. The pallid sturgeon is present in the Platte River, a tributary to the Missouri River, located downstream from a portion of the ARPA; however, the Proposed Action is not expected to affect this habitat provided that mitigation measures for water resources and soils outlined in this document are implemented.

Sensitive Wildlife Species

The following sensitive species have the potential to occur on the project area; however, the species have not been found within the ARPA. If populations are found, mitigation would be applied to avoid disruption of habitat function or of life history requirements. These species should not be impacted by the project: Nelson's milkvetch, Gibben's beardtongue, pale blue-eyed grass, Cedar Rim thistle, long-eared myotis, fringed myotis, spotted bat, Townsend's big-eared bat, pygmy rabbit, swift fox, trumpeter swan, and the Yellow-billed cuckoo (east of Continental Divide). Species that may be affected are discussed below.

White-Tailed Prairie Dog. There are currently 295 white-tailed prairie dog colonies, covering 6,309 acres, mapped within the ARPA (section 3.8.2.2). The BLM requires that development avoid prairie dog colonies whenever possible. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance of some portions of these prairie dog colonies. Direct impacts to prairie dogs, in the form of lost burrows and foraging habitat, would be avoided and are not expected to exceed the impact significance criteria.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Wyoming Pocket Gopher. Based on the known distribution of the species and the availability of suitable habitat, Wyoming pocket-gophers likely occur in the ARPA. If populations are found, mitigation would be developed to protect them. Therefore, impacts are not expected to exceed the impact significance criteria.

White-Faced Ibis. White-faced ibis colonies are always associated with shallow water habitats (Erwin 1983). The Proposed Action is not expected to exceed the significance criteria because development would not occur within 500 feet of riparian and wetland habitats.

Northern Goshawk. In Wyoming, goshawks are found in lodgepole pine and aspen habitat (WGFD 1999). Northern goshawks are known to occur adjacent to the ARPA (WGFD 2003a). Two active goshawk nests were documented outside the eastern edge of the ARPA in the mid to late 1980s in addition to one nest located within the ARPA (See section 3.7.4). With the implementation of mitigation measures for raptor nests (appendix E), implementation of the Proposed Action would not significantly impact the northern goshawk.

Ferruginous Hawk. Ferruginous hawks are known to occur and nest on the ARPA. The primary potential impact to ferruginous hawks from project activities is disturbance during nesting, which could result in reproductive failure. This potential impact would be mitigated by implementing measures in appendix E. Development of the Proposed Action would not significantly impact the ferruginous hawk.

Peregrine Falcon. An available prey base of shorebirds, waterfowl, or small-to-medium-sized terrestrial birds usually occurs within 10 miles of the nest site. Peregrine falcons may migrate through the project area and have been observed on the ARPA (WGFD 2003a), but nesting on or near the project area is unlikely due to the lack of cliffs high enough to provide suitable nesting habitat. If nesting peregrine falcons are found on the ARPA, then all appropriate mitigation measures for raptors would be implemented to prevent or minimize impacts.

Greater Sage-Grouse and Columbian Sharp-tailed Grouse. See section 4.7.3.2.

Mountain Plover. A portion of the potential mountain plover nesting habitat may be disturbed with implementation of the Proposed Action. Impacts to mountain plovers would be minimized by avoiding construction activities in suitable plover nesting habitat during the nesting period from April 10–July 10. Mountain plovers tend to use the same nesting areas from year to year, but the exact nest locations change. Mountain plovers often nest near roads, feed on or near roads, and use roads as travel corridors (USDI-FWS 1999), all of which make the species susceptible to being killed by vehicles. Thus, the operators would be required to inform employees about the potential for roadside and roadway use by this species. The BLM may also identify mountain plover “occupied habitat areas.” If these areas were proposed for disturbance, additional mitigation measure(s) would be required to reduce impacts. Given the implementation of mitigation measures in appendix E, mountain plovers are not expected to be significantly impacted.

Long-Billed Curlew. In Wyoming, the long-billed curlew is an uncommon summer resident, but may be locally common in suitable habitat (WGFD 1999). The long-billed curlew is a BLM sensitive species throughout all of Wyoming. There have been three recorded observations of this species approximately 2 miles northeast of the ARPA and one recorded observation in the east-central portion of the ARPA (WGFD 2003a). The long-billed curlew is not expected to nest

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

on the project area due to lack of habitat, and no significant impacts to this species are expected with implementation of the Proposed Action.

Burrowing Owl. Burrowing owls are known to occur on the ARPA (WGFD 2003a). One active burrowing owl nest was located on the ARPA in 2002. Surveys for this species should be conducted before construction in prairie dog colonies during the owl breeding/nesting season. If nesting owls are found, the same measures used for other raptor species (appendix E) would be applied. Given these precautionary measures, no significant impacts to this species are expected to result from the implementation of the Proposed Action.

Sagebrush-Obligate Song Birds. The sage thrasher, loggerhead shrike, Brewer's sparrow, sage sparrow, and the Baird's sparrow are found in the ARPA (WGFD 2003a). The Proposed Action activities may displace birds to lower quality habitats, which may lead to a reduction in reproduction rates or an increase in predation. The magnitude of direct and indirect habitat loss (section 4.7.3), and continued human presence would exceed the significance criteria (criterion number 4).

Northern Leopard Frog. Sightings have been documented in all counties of Wyoming and this species has a high probability of occurring in areas of the ARPA having perennial water (WYNDD 2003). Provided that measures are taken to avoid disturbance and contamination of perennial water sources (See sections 4.3 and 4.4), no significant impacts to this species are expected from implementation of the Proposed Action.

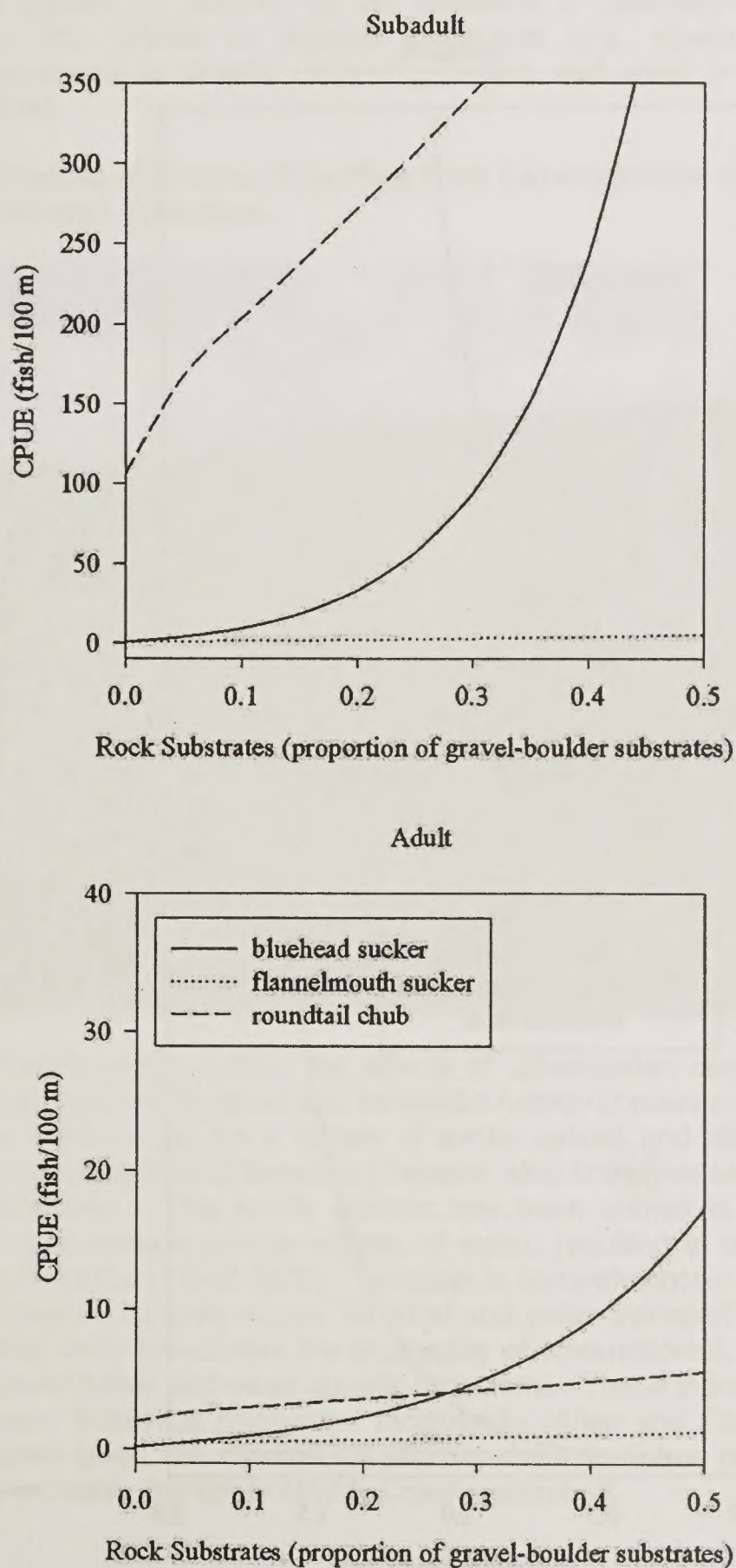
Sensitive Fish Species

Research conducted during the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed, including the ARPA, found the two most consistent habitat associations among sub-adult and adult roundtail chubs, bluehead suckers, and flannelmouth suckers to be positive associations with both rock substrates and deep pools (as depicted on figures 4-1 and 4-2) (Bower 2005). Under the Proposed Action, the primary impacts to these two habitat features are (1) sedimentation from new construction and project-related land disturbance resulting in decreased availability of rock substrates and (2) alteration of local hydrologic conditions by new road construction that could lead to sedimentation and channel adjustments resulting in a loss of deep pool habitats. In addition, fragmentation of aquatic habitats, if any project-related road crossings of Muddy Creek are constructed, could limit access to required habitats or block fish migration. Though no discharges of produced water to the Little Snake River drainage are planned for the project, because of their limited distribution in Wyoming and range-wide, accidental releases of produced waters or other toxic materials to Muddy Creek would pose a potential risk to sensitive fish populations.

The impact of new roads and other facilities on fish habitats can be divided into three categories: construction, presence, and urbanization (Angermeyer et al. 2004). During the construction phase, before interim reclamation, erosion of soils exposed during earth-moving activities accelerates fine-sediment loading in stream channels. Though the biological effects of sedimentation include a variety of ecological interactions (Waters 1995), sedimentation can act to shift habitat structure such as channel depth, pool-to-riffle ratio, percent fines in substrates, and cover availability (Angermeyer et al. 2004). This sediment can extend miles downstream of the construction site and persist in stream channels for years (Angermeyer et al. 2004).

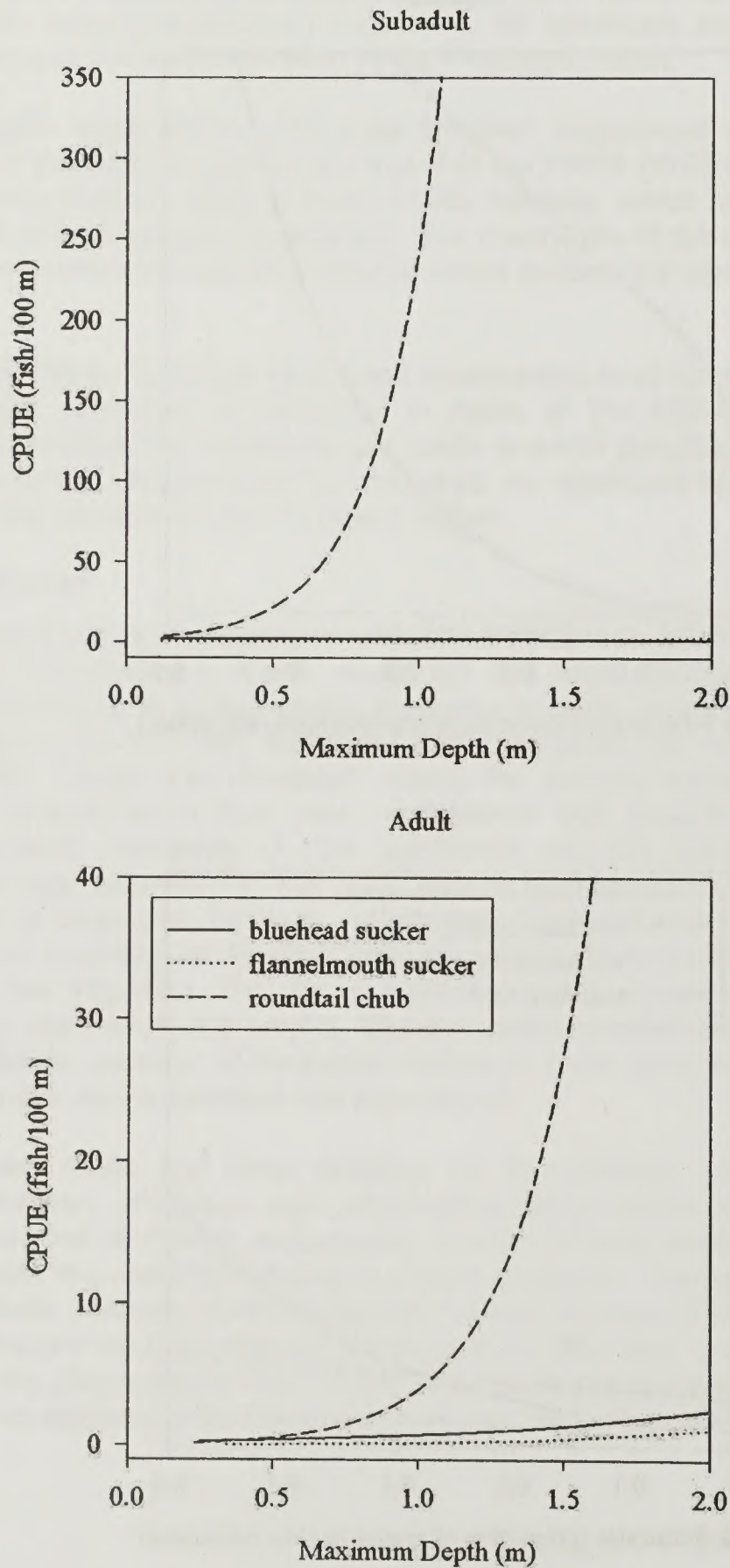
Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Figure 4-1. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of the prevalence of rock substrates at the reach scale from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Figure 4-2. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of maximum channel unit depth from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species above minimum depth thresholds.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

During the presence phase, impacts are primarily associated with the interception of shallow groundwater flow paths by roads. Water is frequently diverted along the roadway and routed to surface water drainage networks at drainage crossings. This can, in turn, alter the timing, routing, and magnitude of runoff, triggering geomorphic adjustments through erosion by channel incision, new gully or channel head formation, or slumping and debris flows (See figure 4-3 and review in Trombulak and Frissel 2000). Channel incision occurs when the base elevation of the stream channel adjusts to account for an alteration of geomorphic parameters, such as sediment supply, flow volume, or channel roughness (e.g., riparian vegetation). Channel incision has been shown to simplify channel geometry and result in the loss of pool habitats (Shields et al. 1994).

Figure 4-3. Example of Erosion Resulting from Concentration of Surface Runoff at Drainage Crossings.



In the case of the Proposed Action, the effects of urbanization can include the detrimental effects of exotic species introductions and increased human presence within the ARPA. Roads provide dispersal mechanisms for a variety of exotic upland and riparian plant species. Of particular concern is the spread of tamarisk (*Tamarix*, also known as salt cedar) within the upper Muddy Creek watershed. This exotic species has been shown to displace native riparian vegetation while consuming a greater volume of water, resulting in reduced water tables and suitability of aquatic habitats (Graf 1978). Tamarisk is currently known to exist in portions of the ARPA and its dispersal typically occurs via wind and water transport. Increased human uses of the area are also likely to increase the probability of unsanctioned, illegal, and unintentional introductions of exotic fishes and other aquatic organisms. These introductions have been cited as one of the major threats to freshwater biodiversity (Allen and Flecker 1993) and warrant careful consideration given the detrimental effects of exotic fishes on native Colorado River Basin fishes present within the upper Muddy Creek watershed.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Stream fishes require habitats for spawning, feeding, rearing, and refuge. The spatial heterogeneity and connectivity of the stream system can necessitate the movement of fishes among these habitats in order to complete their life cycles (Schlosser 1995). Interruption of movement among required habitats by road crossings can have demographic effects, decreasing population viability (Trombulak and Frissel 2000, Gibson et al. 2005). The distributions of the three target species during the summer and fall of 2003 suggest several potential implications of habitat fragmentation relating to access to refuge habitats and subsequent ability to recolonize adjacent reaches (Bower 2005). In addition, movements of the three species observed during 2005 suggest that required habitats exist in spatially distinct portions of the watershed, thus requiring movement of individuals in order to complete their life history requirements (Compton 2005).

Eighty-acre spacing of coal bed methane well locations under the proposed action would result in a road density of 7.1 miles/mile² within the upper Muddy Creek/Grizzly SMA. This includes new road construction (0.5 mile per well location) as well as 100 miles of existing road. In addition, crossings of Muddy Creek are anticipated as a result of the Proposed Action, though the number and specific location of these crossings has not yet been determined.

Research within the Little Robbers Gulch drainage (bordering the ARPA on its western edge) has demonstrated the effects of roads, natural gas drillpads, and pipelines on sediment production and runoff (Wollmer 1994). This work examined the effect of road densities of 2 mile/miles² including associated well pad and pipeline facilities on local sediment production and runoff. Wollmer (1994) observed an increase in local sediment production and runoff when compared to unaltered rangeland sites. While this study examined local erosion caused by roads, the study did not address the effects of flow interception which can lead to altered runoff timing, routes, and magnitudes. It is these hydrologic alterations compounded at the drainage scale that are most likely to result in geomorphic adjustments through erosion, causing sedimentation or loss of habitat features such as deep pools.

Roundtail Chub, Bluehead Sucker, and Flannemouth Sucker. The Proposed Action would significantly impact the habitat of these species within the ARPA based on the impacts of new roads and other facilities on the habitat features found to be important to roundtail chubs within the upper Muddy Creek watershed as well as the effects of habitat fragmentation on the ability of roundtail chubs to access required habitats. In addition, the Proposed Action might preclude improvement of their status as prescribed in the Range-wide Conservation Agreement for Bluehead Suckers, Flannemouth Suckers, and Roundtail Chubs (criterion 4) (UDNR 2004). The EIS contains many best management practices including detailed mitigation measures that will be used following site-specific reviews of the operator's annual planning proposals. The BLM IDT and cooperating agencies will work together to determine the most effective combination of COA's, best management practices and other necessary mitigations to minimize effects from the proposal.

Colorado River Cutthroat Trout. Given the absence of Colorado River cutthroat trout from the ARPA and portions of Muddy Creek downstream of the ARPA, the Proposed Action is not likely to impact the habitat of this species.

4.8.3.3 Alternative A (No Action)

There would be no additional disturbance as a result of this alternative.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.8.3.4 Alternative C

Wildlife

Alternative C would proceed with development across the ARPA similar to the Proposed Action, but would be constrained by critical/sensitive resource concerns. These sites would have additional protective measures beyond what is already provided by applying standard mitigation stipulations (appendix E, appendix H, appendix L, and BMPs). Examples of some of these sensitive sites are steep slopes, soils with high runoff potential, big game crucial winter range, and greater sage-grouse nesting and brood-rearing habitat. Because of these sensitive issues, there would be less surface disturbance allowed per section on BLM lands. This would reduce the surface disturbance on BLM lands by 68 percent relative to the Proposed Action. There would be less than 20 acres of pre-reclamation and 5 acres of post-reclamation surface disturbance with a maximum of four pads per section in sage-grouse nesting and brood-rearing habitat. The overall reduction in acres initially disturbed would reduce habitat fragmentation and indirectly increase potential recruitment of native species re-establishing disturbed sites. This would decrease the overall habitat loss and displacement effects to wildlife species, as well as reduce impediments within movement corridors. A reduction in disturbance of wildlife habitat on BLM lands by 68 percent would benefit all species and reduce the time required, long term, to return to the functionality of the habitat in the project area. These benefits would be realized to the greatest extent in the central and southern portions where there is a preponderance of BLM lands. The extreme southern portion and the northern half would realize some benefit of these additional mitigations, but their effectiveness would be reduced due to the lack of equivalent mitigation on private and state lands. Soil mitigation, restricting surface disturbance on high runoff potential soils, would also indirectly protect over half of the saltbush steppe habitat within the ARPA. This would benefit species such as white-tailed prairie dog, mountain plover, and burrowing owl. Direct disturbance would be reduced by 68 percent on BLM lands, reducing impacts to all BLM sensitive species. Impacts would not exceed the significance criteria for sagebrush-obligate species under this alternative.

Fish

Development protection measures within the upper Muddy Creek Watershed/Grizzly SMA would benefit sensitive fishes by limiting the alteration of local hydrologic conditions that create and maintain habitat features of importance to sensitive fishes. Two of these habitat features, rock substrates and deep pool habitats, have been shown to be of importance to sensitive fishes (Bower 2005) and are thought to be susceptible to loss or decreased suitability as a result of hydrologic alteration from road construction. Maintenance of existing road densities through the use of existing road paths, as well as incorporation of appropriate road designs (such as low-impact road designs on slopes of less than 8 percent), would result in a net decrease in erosion from the existing road network. Particularly problematic road paths that are causing accelerated erosion would be identified within transportation planning efforts. By reclaiming these problematic road paths, additional road lengths would be available for new road construction when lease holdings could not be accessed along existing paths, without resulting in a net increase in road density or erosion.

Additional special protective measures within the upper Muddy Creek Watershed/Grizzly SMA would preclude the fragmentation of fish habitats by road crossings, thus ensuring that access among the diverse habitats required by sensitive fishes is maintained. These measures would also limit the potential spread of exotic species that often have detrimental direct or indirect impacts on sensitive fishes and their habitats.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Roundtail Chub, Bluehead Sucker, and Flannemouth Sucker. Given the implementation of special protective measures identified for the upper Muddy Creek Watershed/Grizzly SMA, Alternative C would not significantly impact the habitat of these species within the ARPA.

Colorado River Cutthroat Trout. Given the absence of Colorado River cutthroat trout from the ARPA and portions of Muddy Creek downstream of the ARPA, Alternative C is not likely to impact the habitat of this species.

4.8.3.5 Alternative D

Under Alternative D, potential impacts are similar to those described with the Proposed Action (section 4.8.3.1) for the black-footed ferret, bald eagle, Colorado pikeminnow, bonytail, humpback chub, razorback sucker, and pallid sturgeon. Refer to the discussion in the Proposed Action for potential impacts for each species; they are the same for Alternative D. Impacts are also similar for BLM sensitive fish species.

Significant impacts to three sensitive fish species are possible. As described under the Proposed Action, roundtail chub, bluehead suckers, and flannemouth suckers would be significantly impacted.

4.8.4 Impact Summary

4.8.4.1 Proposed Action

Threatened and Endangered Species

Implementation of the Proposed Action would result in direct loss of habitat from surface disturbance associated with the construction of well sites, related facilities, access roads, and pipelines. In addition, some wildlife species would be indirectly impacted by displacement from habitats in the vicinity of the project area due to the presence of human activities associated with the construction and operation of wells. Small portions of potential black-footed ferret habitat may be disturbed. The potential for collisions between bald eagles and motor vehicles would also increase due to the construction of new roads and increased traffic levels on existing roads. The primary source of potential risks to the fish species is increases in suspended sediments and sedimentation from land disturbance from project activities. The intensity of these impacts may decrease with the completion of the construction phase and with the onset of reclamation efforts on disturbed areas.

None of the threatened and endangered species found downstream of the ARPA within the Colorado River system are known to occur in the ARPA; therefore, there would be no direct impacts to these species. However, water depletion as a result of project development, even though minimal, could indirectly impact these species. Implementation of all mitigation measures for water and soils would help reduce other potential impacts. No produced water from the ARPA would be discharged to the Little Snake River drainage; therefore, produced water discharges do not pose a risk to these species. Accidental releases of produced waters or other materials could occur. However, these materials would become highly diluted before they would reach any downstream waters where these species occur; consequently, the potential risks from such occurrences are negligible. Any water depletion within the Colorado River system results in a "may affect, likely to adversely affect" determination for threatened and endangered species found in and along this river. Therefore, BLM would initiate formal consultation with USFWS for those species. If any threatened or endangered fish species are

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

identified within the ARPA, the BLM would consult with the USFWS and develop a protection plan for the fish.

Sensitive Species

With the implementation of the Proposed Action, direct loss of habitat would result from surface disturbance associated with the construction of well sites and related access roads and pipelines. Small portions of potential habitat for several sensitive species may be disturbed. The intensity of these impacts would decrease with the completion of the construction phase and with the onset of reclamation efforts on many of the disturbed areas. The application of prescribed avoidance, monitoring (Wildlife Monitoring and Protection Plan, appendix E) and mitigation measures (appendix H) would reduce the impact potential. Impacts would still exceed the significance criteria for sagebrush-obligate species. Alteration of fish habitat suitability would result in significant impacts to sensitive fishes (criterion number 4).

4.8.4.2 Alternative C

Overall impacts to special status species would be very similar to the Proposed Action. Direct disturbance on BLM lands would be reduced by 68 percent reducing potential impacts to all special status species. Impacts would not exceed the significance criteria for sagebrush obligate species under this alternative. Development protection measures applied to the upper Muddy Creek Watershed/Grizzly SMA would help to maintain the suitability of habitats for sensitive fishes.

4.8.4.3 Alternative D

Overall impacts to special status species would be the same as those described under the Proposed Action. There is some potential for reduction of impacts due to the acreage limitation for disturbed and unreclaimed areas. In addition the disturbance reduction goal (approximately 20 percent) may result in reduced impacts due to reduced initial disturbance. Because the overall number of wells through the life of the project is unchanged, those species significantly impacted under the Proposed Action will remain so under Alternative D (criterion number 4).

4.8.5 Additional Mitigation Measures

There are no additional mitigation measures identified for threatened and endangered species or BLM sensitive species unless identified mountain-plover-occupied habitat areas are proposed to be disturbed. If this happens, the following additional mitigation measures are advised:

- Surface disturbance would occur outside identified occupied habitat for mountain plovers where feasible.
- Within a half-mile of the identified mountain-plover-occupied habitat area, speed limits would be posted at 25 mph on resource roads and 35 mph on local roads during the brood-rearing period (June 1–July 10). BLM anticipates that enforcement of speed limits will occur by the companies advising and disciplining their employees and contractors as necessary to comply with speed limits.
- Access roads would be realigned to avoid the identified mountain-plover-occupied habitat area.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

- To protect mountain plover in occupied habitat, traffic would be minimized from June 1–July 10 by car-pooling and organizing work activities to minimize trips on roads through the mountain-plover-occupied habitat area.
- To protect mountain plover in occupied habitat, fences, storage tanks, and other elevated structures would be either constructed as low as possible or would incorporate perch-inhibitors into their design.
- To minimize destruction of nests and disturbance to breeding mountain plovers, no ground-disturbing activities would occur from April 10–July 10 unless surveys consistent with the Plover Guidelines or other USFWS-approved method find that no plovers are nesting in the area.
- A plugged and abandoned well within a half mile of the identified mountain-plover-occupied habitat area would be identified with a marker 4 feet tall with a perch inhibitor on the top of the marker.

4.9 Recreation Resources

4.9.1 Introduction

This section addresses the potential impacts of the Proposed Action and alternatives to recreational resources in the ARPA. The analysis focuses on the principal form of recreation within the ARPA, which is big game hunting, and considers both direct and indirect impacts to recreation resources.

The ARPA contains no developed recreation sites. OHV use is limited to existing roads and two-tracks, except for retrieving downed game animals or accessing primitive campsites. These exceptions do allow the creation of new two-tracks which can further fragment habitat, cause erosion and sedimentation, and reduce vegetative cover. Dispersed recreation in the ARPA occurs primarily on BLM land and consists largely of hunting by residents and visitors from outside the region. Camping and OHV use within the ARPA occur most often in conjunction with hunting. There is some seasonal pleasure driving and snow machine use, which often incorporate wildlife viewing as a significant reason for visiting the area.

The ARPA contains two ACECs—Sand Hills ACEC and Jep Canyon ACEC—which merit intensive management of surface-disturbing activities for wildlife habitat (USDI-BLM 1990 and 2003b).

The health and abundance of wildlife populations directly affect the quality of hunting in the ARPA. When wildlife populations fluctuate, so do wildlife-based recreational opportunities. To determine impacts to hunting, the recreation analysis relies on the analysis of impacts to big game wildlife in the ARPA (section 4.7). The narrative and maps (M-21 through M-29) presented in section 3.7 were evaluated for their potential effect on hunting because of a loss of carrying capacity or the displacement of game.

Impacts to visual resources in the ARPA, identified in section 4.10, also were considered for effects on recreation. Visual resources influence the character of outdoor opportunities by affecting the recreation setting, as do other effects of gas development such as noise, dust, and traffic on recreational access routes.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.9.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with recreation resources:

- To ensure the continued availability of outdoor recreational opportunities, to meet legal requirements for the health and safety of visitors, and to mitigate conflicts with other resource uses.

The main concern for the recreation analysis is displacement of existing recreational use by the Proposed Action and alternatives. Impacts to recreation would be significant if:

1. An action would cause displacement of hunting, wildlife viewing, and driving for pleasure from the ARPA when no other comparable area nearby could reasonably provide substitute opportunities.

4.9.3 Direct and Indirect Impacts

The Proposed Action and alternatives would potentially have both direct and indirect impacts to recreation. Direct impacts to recreation resources occur because of the physical disturbance and removal of vegetation from the construction of facilities; the visual impacts of facilities and activities; and from the noise, traffic, and visual distraction of human activity.

Examples of direct impacts include the removal of wildlife habitat that may affect game populations and the intrusion of gas facilities on a natural-appearing landscape. Indirect effects to recreation resources include changes to recreation use and experiences on lands near directly impacted recreation resources. Examples are disturbances of nearby recreation settings by traffic, noise, and landscape changes associated with gas facilities and related activity that would intensify visitation at other undeveloped areas nearby.

Most effects to recreation from the Proposed Action and alternatives would tend to decrease in the quality of recreation opportunities and the appeal of the setting for most recreationists. New roads associated with development may be considered useful in that they provide increased access for activities such as hunting, but roads fragment wildlife habitat and the associated increase in development activity would displace wildlife. Two-tracks that are lightly traveled during hunting season do not interfere with, and may be conducive to successful hunts, whereas industrial traffic on improved roads is not. Hence new improved roads do not benefit hunting. As development of the project progresses and game is displaced, success rates would be expected to decline along with the size of the herd remaining in the project area. The opportunity to pursue game on foot is diminished when an abundance of roads provide access to road hunters that could scare game from the area.

Indirect impacts to recreation can occur from population growth associated with the project's workforce. This factor was considered but not pursued further in the analysis of the Proposed Action and alternatives because the project is unlikely to cause significant long-term population effects, as described in section 4.12. Impacts to recreation from potential residential development in the future are also described in chapter 5.

The principal recreation impact likely to be associated with the Proposed Action and alternatives is the change in big game hunting opportunities because of habitat loss and wildlife

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

displacement. The underlying effects upon wildlife habitat and behavior were analyzed in section 4.7. Changes to the landscape, analyzed in section 4.10, also would affect hunters who value a natural setting as part of their experience and pleasure drivers who visit the ARPA to view the scenery and watch wildlife. These impacts would occur as the direct and indirect results of a higher density and wider distribution of gas development within the ARPA compared to existing conditions.

4.9.3.1 Proposed Action

As described in detail in chapter 2, a total of 2,000 new natural gas wells would be drilled and developed under this alternative during the next 20 years with an expected life of project of 30–50 years. Well placement within the ARPA is not known at this time, but it is assumed that development would likely be concentrated within or near existing pods, although some wells would also be drilled in outlying areas where development currently does not exist.

Impacts to Hunting

The big game species potentially affected by the Proposed Action are mule deer, elk, and pronghorn antelope. The proposed level of development would disturb approximately 15,800 acres of wildlife habitat over 20 years, but interim reclamation, as intended by the operator (appendices B and K), would reduce long-term disturbance and direct loss of habitat to a total of 6,200 acres.

In addition to the direct loss of habitat due to construction of well pads and associated roads, pipelines and utilities, disturbance from human activity and traffic would lower the use of habitat immediately adjacent to developed areas and cause wildlife displacement from an area larger than the actual disturbed sites. As noted in section 4.7.3.1, this displacement effect has the potential to result in local reductions in wildlife. As also noted in section 4.7.3.1, despite acclimation and re-occupation, the increased human footprint over all on a previously lightly developed area is detrimental to big game species populations if adjacent, undisturbed habitats are at carrying capacity.

The extent of wildlife displacement is impossible to predict. Impacts to hunting would occur in the ARPA proportional to the displacement of big game in connection with the Proposed Action. If hunter success rates declined, use of the hunt areas would be likely to decline as well. The impact would be borne primarily by local and regional hunters, especially local hunters for whom the benefits of the ARPA would be diminished as a convenient and economical place to hunt. The impact would also be borne by commercial outfitters permitted to use the ARPA (See table 3-42). Increased development in the ARPA—with its potential to displace big game and its effect on the recreation setting—would reduce the appeal of the project area for a commercial clientele whose values include a successful harvest in an attractive recreational setting.

Impacts to the Recreation Setting

For many hunters and other outdoor recreationists, a natural setting is critical to the quality of the recreation experience. In the ARPA, the Proposed Action and action alternatives would potentially affect the recreation setting due to traffic, dust and noise and by impacting visual resources.

As section 4.10 concludes, the Proposed Action and action alternatives would have a high, impact on the natural appearance of the landscape. This level of degradation of the scenery would potentially affect hunters and other recreation visitors to the ARPA.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Research has found that hunters participate in this activity for many reasons. Though hunting success is the predominant reason, enjoyment of the outdoors and the environment has a key role for many hunters (Manning 1986). Therefore, the visual quality of the setting would likely be important to many hunters in the ARPA, and degradation of the scenery in the project area would diminish their enjoyment and the satisfaction of the hunt.

For pleasure drivers and wildlife viewers, natural scenery and productive wildlife habitats are an essential part of the recreational setting. These recreational visitors would likely be very sensitive to changes in visual quality, and impacts to visual quality in the project area would likely diminish their enjoyment of the outdoor experience.

For hunters, wildlife viewers, and pleasure drivers, industrial traffic on roads in the ARPA would potentially detract from the recreational character of the setting in the ARPA. The operator is committed to posting appropriate warning signs, implementing safety training for the operators of project vehicles and equipment, and requiring project vehicles to adhere to low speed limits (See appendix K). These project management practices would potentially limit conflicts between project activity and recreation use in the ARPA. However, some level of conflict with the expectations of recreationists is unavoidable, particularly during drilling and field development activities. The risk of traffic accidents is significantly increased by vehicles associated with development and production in the ARPA.

Noise levels associated with drilling, field development, and operations activities may temporarily exceed threshold EPA average noise levels at specific locations within the ARPA, as noted in section 4.15. This would directly detract from the relative silence of undisturbed country customarily sought by recreational visitors engaged in hunting, wildlife observation, and sightseeing. Noise impacts due to drilling, field development, and traffic may be unavoidable, at least during the drilling and development phases, after which much of the noise would abate. However, noise associated with compression and individual well pumps would be long term in duration and would potentially displace recreation to other areas.

Impacts to hydrologic systems and soil-stabilizing vegetation would impact the recreation experience by altering the undeveloped setting present in most of the ARPA. The proliferation of opportunistic weeds on disturbed soils would further alter the setting and inhibit the success of reclamation.

The duration of the effects would be for the life of the project—which may affect more than one generation of recreation user—but the intensity of the effects would be lower after drilling and construction ends. The Proposed Action would likely displace some dispersed recreation use from the ARPA to areas for hunting and wildlife viewing that are farther away and are themselves likely to be under increasing pressure for development.

As noted in chapter 3, there are no recreational visitation counts for the ARPA, but overall use is believed to be low, except during and just prior to hunting season, which occurs primarily in the fall (USDI-BLM 2000a). Low visitation during the rest of the year is due to low population densities in proximity to the area and the historically seasonal nature of the road network. Snowdrifts in winter and any rains the rest of the year have, in the past, made most of the roads intermittently impassable.

Visitation to the ARPA may increase in the future because of recent improvements in surfacing on BLM and county roads. New roads developed in the ARPA to support gas development may

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

also encourage use by opening access to new areas. With increased use over time, the impact of the Proposed Action may be higher. Another factor expected to promote visitation to the area is the stabilization and interpretation of the JO Ranch that was recently acquired by BLM near the Sand Hills. The Continental Divide National Scenic Trail is not likely to notably increase visitation to the project area, despite its being within 3 miles of the northeastern boundary of the ARPA.

In conclusion, the impacts to the predominant recreation activities in the ARPA—hunting, pleasure driving, and wildlife viewing—would be significant. The Proposed Action would diminish the wildlife presence, degrade scenery, and introduce traffic and noise. The natural setting would be converted to an industrialized setting by development of the Proposed Action. These effects would likely make recreating in the project area significantly less desirable.

4.9.3.2 Alternative A (No Action)

Under the no action alternative, the Proposed Action would not be approved. The ARPA's recreation experience would continue to be affected by existing facilities and interim drilling, but no new impacts to recreation and hunting would be introduced by the no action alternative.

4.9.3.3 Alternative C

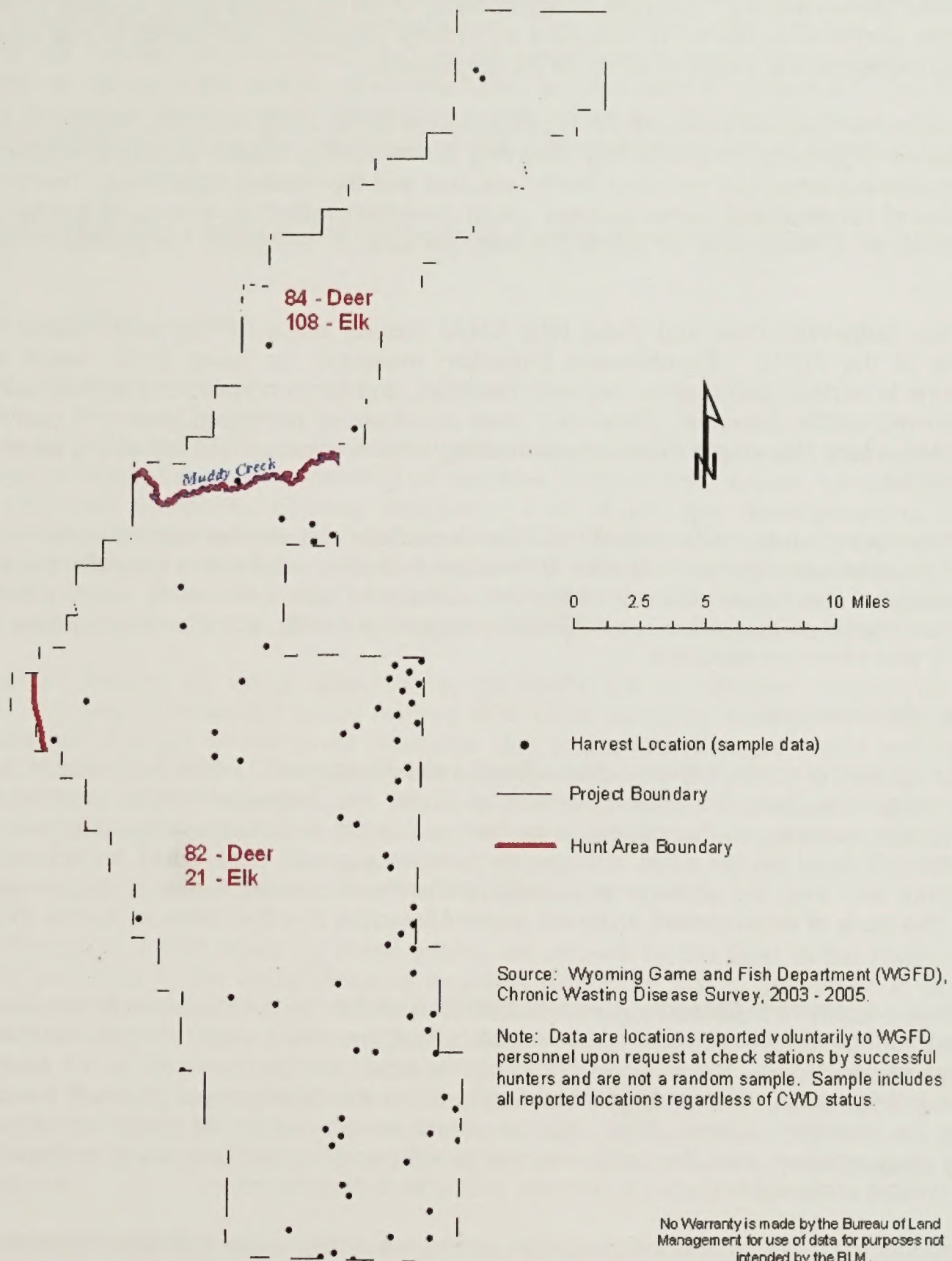
Some of the development protection measures included in Alternative C would reduce impacts to recreation. The following limitations on surface disturbance would help retain the existing quality of recreation opportunities in the ARPA: in slopes over 8 percent, vegetation communities with high wildlife values, rare vegetation communities, proximity to water or wetlands, big game crucial winter range, grouse brood-rearing and nesting habitat, silver sagebrush/bitterbrush communities, and soils with high runoff potential. The following would also contribute to preservation of the recreational setting: road density limitations for grouse brood-rearing and nesting habitat and some SMAs along with requirements for prompt interim reclamation; low impact road designs; careful siting of well pads, roads, and facilities; and dust abatement techniques.

Data from the WGFD random surveys were used to identify the areas of concentration of deer and elk hunter success in the ARPA. These areas are illustrated on map M-41. As this figure shows, the hunter success is concentrated in five general areas, all of which fall within the boundaries of WGFD Hunt Area 82, one of the most heavily hunted areas in the state. The areas are generally known as the Sand Hills, Deep Gulch and Cow Creek, Wild Cow Creek, Cherokee Creek, and Wild Horse Creek. Development in or adjacent to these areas would be expected to displace big game, and thus big game hunting to other areas where development is not occurring.

Direct loss of habitat due to construction of well pads and associated roads and pipelines would lead to some wildlife displacement in these areas. Displacement due to habitat loss can be minimized but not avoided. This type of displacement would have impacts to hunting in the ARPA and would be disproportionate because of the importance of these areas to game herds and thus to hunting.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-41. Locations of Successful Hunts.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

A second type of impact, the disturbance of individual game animals by human activity and traffic would have effects on hunting. The long-term displacement of game herds because of sustained activity and noise is addressed in section 4.7. Very short-term displacement of individual animals or small groups would also occur as an immediate, direct response to traffic, noise, and human activity. This type of disturbance, which can cause game to avoid an area for the better part of a day or so, is disruptive to hunting. Repeated disturbance of this kind could have an impact on the quality of an entire hunting season.

Because hunter success in the ARPA is concentrated in the areas described above, short-term disturbance of game by project activity occurring during hunting season would potentially have a disproportionate impact by reducing hunter success and the hunting experience. The impact to the areas of concentrated hunter success would potentially reflect on a reduced quality hunting experience in affected parts of the ARPA and, perhaps, in the game management unit as a whole.

The Cow Butte/Wild Cow and Sand Hills SMAs include some of the most heavily hunted portions of the ARPA. Development protection measures for these SMAs would include limitations to surface disturbance and road densities, and fence conversions to BLM standards for improved wildlife passage. These and other development protection measures particular to each SMA would help retain the quality of hunting, wildlife viewing, and recreation experiences in the ARPA.

The potential for up to a 68-percent reduction in surface disturbance and other development protection measures associated with Alternative C would reduce the project's impacts on recreation, but the overall network of facilities associated with 2,000 wells would still have a significant impact on recreation in the ARPA by displacing wildlife, and therefore hunters, wildlife viewers, and other recreationists.

4.9.3.4 Alternative D

Impacts to hunting and to the recreation setting under Alternative D would be similar to, but of a lesser magnitude than the impacts described under the Proposed Action (section 4.9.3.1 above). The acreage of the project area that would be disturbed at any one time under Alternative D (goal of 6.5 acres average disturbance per well site) would be approximately 20 percent less than the acreage anticipated under the Proposed Action (7.9 acres per well site). The pace of development analyzed under Alternative D is the same as for the Proposed Action.

Impacts to recreation in Category A areas would be less than in the Proposed Action due to the reduced surface disturbance and more careful mitigations, which would reduce visual impacts and loss of vegetation. Recreationists and wildlife would still be displaced by the equipment, human activity, noise, dust and industrial traffic during the development phase of the project. During the operation phase, visual impacts would remain, as would some human activity, habitat fragmentation, and the noise associated with working facilities, so even these areas would remain undesirable places to recreate until after final reclamation.

The impacts to hunting and to the recreation setting are similar under both the Proposed Action and Alternative D because reclamation success would not necessarily reduce the amount of disturbance in the short and long term under both alternatives even though the analyses of both alternatives assumed that operators' reclamation efforts would be successful.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.9.4 Additional Mitigation Measures

The recreation analysis assumes the implementation of mitigations adopted as a result of the analysis of impacts to recreation, wildlife resources, and visual resources. There are no relevant operator-committed mitigation measures. The operator may choose to include mitigations for habitat enhancements in nearby undeveloped areas to compensate for degradation of habitat in the ARPA; other measures, as discussed in section 4.7; and BMPs applied at the annual planning level. Minimizing activity during hunting season would not be an effective mitigation due to the disturbance of wildlife that normally occurs as a part of hunting activities.

No additional mitigation measures are necessary to specifically address impacts to recreation resources.

4.10 Visual Resources

4.10.1 Introduction

The landscape within the ARPA contains broad areas of grasslands, sagebrush, and tree cover, with the type of vegetative cover depending on variables, such as soils, aspect, elevation of the surface, and water availability. Existing disturbance from oil and gas development is about 600 acres. This disturbance—about 0.2 percent of the 270,080 total acres in the ARPA—comprises unreclaimed areas from prior development of well pads, compressor stations, and containment ponds. A small portion of the remainder of the ARPA has been modified by improved and unimproved roads, power lines, constructed ponds, and irrigated cropland.

The issues of concern for visual resources in the ARPA are (1) whether changes to the landscape from gas development would exceed BLM visual resource management objectives and (2) whether changes in the visual resources due to gas development would potentially affect other users of the ARPA. The objective of VRM Management Class III is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but ***should not dominate the view of the casual observer***. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

The classification of ARPA lands by visual quality, as defined by the BLM in the RMP, was determined according to the visual resource inventory procedure that is prescribed in BLM's Visual Resource Inventory Manual 8410 (USDI-BLM 1980). The BLM's visual resource considerations during the siting of oil and gas facilities seek to minimize impacts to the extent possible and to avoid impacts that exceed allowable thresholds under existing VRM classifications. During the siting of specific oil and gas facilities within the ARPA, opportunities will be sought to minimize the prominence of structures, minimize unavoidable open disturbance during operations, and align roads and other ROWs for reduced visibility and contrast with natural features.

The analysis assumes that measures presented in the Reclamation Plan (appendix B) would be implemented. Because of the large geographic area covered by the project and the fact that the specific location of project facilities is unknown at this time, the reclamation measures were presented in the plan in a general, non-specific manner. The final choice of measures to be applied at any given location would be identified by the BLM in coordination with the operators.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

In the Great Divide RMP, BLM classified 259,000 acres of the 270,000 acres in the ARPA (about 96 percent) as VRM Class III, placing it in the category that comprises about 75 percent of all land in Great Divide Resource Area. The rest of the land in the ARPA, located in the vicinity of Dad, is classified as VRM Class IV.

The management objective for VRM Class III is to allow only a moderate level of contrast between project features and the existing landscape. Moderate contrast means that project features should be selected, located, and designed so as to not become dominant in the landscape, though they may be evident to the viewer and may even attract the viewer's attention. VRM Class IV allows a strong visual contrast with the landscape, meaning project features may dominate views and even be the focus of viewer attention, though even in Class IV BLM may encourage the use of topography and vegetation to screen project features and reduce visual contrast.

4.10.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objective associated with visual resources:

1. To minimize effects on visual resources while maintaining the effectiveness of land-use allocations.

Visual impacts are considered significant if an activity or development in an area:

1. Is incompatible with the designated VRM class objective,
2. Becomes an unacceptable feature of the landscape or visual horizon, and
3. Has a "High" predicted visual contrast, as detailed in table 4-8.

Table 4-8. Criteria for Assigning Summary Assessment of Impacts to Visual Resources for the Development Alternatives.

Level of Impact	Criteria
High	Predicted visual contrast would be higher than the level of change to the characteristic landscape allowable by the visual resource management (VRM) classification. For example, introduced facilities in VRM Class III that dominate the landscape by becoming the primary focus of and holding viewers' attention would be rated as a high impact.
Moderate	Predicted visual contrast would be equal to but not exceed the level of change to the characteristic landscape allowable by the VRM classification. For example, introduced facilities in VRM Class III that are evident in the landscape and attract attention without dominating the view of the casual observer would be rated as moderate impact.
Low	Predicted visual contrast would be lower than the level of change allowable by the VRM classification. For example, introduced facilities in VRM Class III that are evident to viewers but otherwise conform to the landscape's natural lines, forms, colors, and textures would be rated as a low impact.

In determining the level of visual contrast to be expected from the alternatives, this analysis has followed guidance on visual contrast rating from the BLM Visual Contrast Rating Manual H-8431-1 (USDI-BLM 1999). The degree to which a management activity affects the

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

visual quality of a landscape depends on the visual contrast created by the project and the existing landscape. Briefly, the visual contrast introduced to the landscape by features of the proposed project is rated as weak, moderate, or strong based on a comparison of the development's form, line, color, and texture to the same elements in the characteristic landscape.

To arrive at an impact rating, the analysis compares the highest visual contrast that the project would cause with the management objective for VRM Class III, which, as noted, comprises 96 percent of the ARPA. The impact rating to be attributed to the alternatives are assessed by applying criteria from table 4-8.

The VRM objectives for the ARPA were established by the RMP through the classification of all field office lands. The classifications are the sole determinant of the allowable level of visual impact. However, the RMP also includes guidance for management decisions in a multiple use context, such as where visual and mineral resources co-exist. The RMP includes an overall objective for visual resource management in the resource area as a whole that calls for minimizing the impacts to visual resources while maintaining the effectiveness of land-use allocations for activities based on other resources (USDI-BLM 1990). Similarly, the overall objective stated in the RMP for oil and gas resource management throughout the resource area calls for providing opportunities for development of mineral resources while protecting other resource values (USDI-BLM 1990).

The task of effects on visual resources while maintaining the effectiveness of land-use allocations is undertaken by BLM as a part of site-specific analyses of specific project proposals. These analyses are required once a site-specific proposal and additional resource information have been submitted to the BLM for approval. The site-specific analyses would occur after issuance of the ROD by BLM and before surface disturbance pursuant to an individual APD or ROW grant would be allowed to take place on federal surface or minerals.

The ARPA is a large area and the alternatives are general in describing how project features would be located within the ARPA. This analysis proceeds by considering the level of visual contrast that would result from seeing typical project features from selected roads within the ARPA. The selected roads considered by the analysis are the maintained roads that access the principal areas within the ARPA where gas development would occur and where other uses, such as recreation, occur as well.

4.10.3 Direct and Indirect Impacts

4.10.3.1 Proposed Action

Features of the Proposed Action that would impact visual resources include structures (wellheads, tanks, generators, compressor units, etc.), structure sites (reclaimed to production size), roads with adjacent utility ROWs (reclaimed to the life-of-project travel surface), and unreclaimed surface areas. To mitigate visual impacts, facilities would be painted Shale Green or Brush Brown (or other non-reflective color approved by the BLM), sites would be cleaned up, and interim reclamation activities initiated. In general, interim reclamation would occur concurrently as sections of the project are completed. Revegetation realized through successful interim reclamation would potentially create continued contrast with the existing landscape throughout the life of the project. The period of time that this contrast would exist would be

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

variable, since it depends on the success of the reclamation measures and on the time needed for primary succession to return disturbed areas to pre-disturbance vegetation conditions.

The Proposed Action would potentially increase the amount of oil-and-gas-related disturbance in the ARPA approximately ten fold from current impacts from the Atlantic Rim pods. This would increase the likelihood of seeing a landscape in the ARPA that includes oil and gas structures, the bare soil of well pads, and other facility sites and roads. The appearance of gas development at 80-acre spacing would create unavoidable contrast with natural landscapes in the ARPA, especially in tracts of continuous vegetation. The highly contrasting and difficult-to-conceal elements of development that appear with greater frequency at the proposed density are the bare pads where well and other facilities are constructed and the network of access and service roads.

The greatest potential for seeing visual contrasts from the Proposed Action would be from the principal roads of the ARPA. These roads would likely be traveled by private property owners and recreationists, as well as by ranch and oil-and-gas-related personnel. Sensitivity to the level of visual contrast from oil and gas development would likely be highest among recreationists, who include hunters, sightseers, and wildlife observers.

Table 4-9 lists roads where users would potentially see foreground/middle ground views of oil and gas structures and related change. These are views where contrasting features would be less than 3 miles from the viewer, according to the Visual Resource Inventory Manual H-8410-1 definitions of distance zones for visual resources analysis. The roads in table 4-9 either access the northern or the southern part of the ARPA.

Approximately 65 percent of the VRM Class III lands in the ARPA are visible from one or more of the state, county or BLM roads in or adjacent to the project area (map M-6). Approximately 67 percent of the Class III federal lands are visible. Therefore seeing development with strong contrast to the natural landscape that dominates the view of sensitive observers is quite probable and most likely unavoidable under the Proposed Action.

Users of CCR 503 and 608, as well as BLM 3309, would also occasionally see panoramic views with the facilities, roads, and reclaimed areas of the Proposed Action in the background.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Table 4-9. Roads in the ARPA Where Users Would Likely See Views of Oil and Gas Facilities under the Proposed Action.

Northern Part of ARPA		Southern Part of ARPA	
Number	Common Name	Number	Common Name
CCR 605	Twenty Mile Road Daley Road	CR 503	Dixon Road
		CR 608 (west end)	Dad Road
		CR 608 (east end)	Lone Butte Road
		BLM 3305	Willows Road
		BLM 3308	Cow Butte Road
		BLM 3309	Wild Horse Road
		BLM 3320	Muddy Mountain Road

Notes:

CCR – Carbon County Road

CR – County Road

All roads would likely access foreground to middle ground views of facilities within 3 to 5 miles or less of the viewer.

The northern part of ARPA includes the Red Rim and Jolly Roger federal lease units.

The southern part of ARPA includes the Doty Mountain, Cow Creek, Sun Dog, Blue Sky, Brown Cow, Boulder Creek, and Burbank Draw federal lease units.

Some portions of the roads identified in table 4-9 already have views of wells developed in the interim drilling period. As these views indicate, gas development does contrast with the characteristic landscape, even when designed and sited specifically for the ARPA. Judging from these examples, the greatest level of visual contrast due to the Proposed Action would occur because of bare soils on well pads, production facilities and structures, and associated roads. Specifically, geometric lines associated with these activities would contrast strongly with the characteristic vegetation and topography of the ARPA.

The reclaimed surface disturbance introduced by the Proposed Action would contrast with the ARPA landscape to a lesser degree. Reclaimed areas would contrast with undisturbed cover for several years because vegetation is slow to recover in most of the ARPA. While the VRM Class III rating allows for development so long as it does not dominate the view of the casual observer, 80 acre spacing would clearly create visual impacts that would dominate the view unless the development was very well mitigated. Hunters, sightseers, and wildlife observers would likely be sensitive to the visual impacts of development because the visual quality of the setting is integral to the quality of the recreation experience. Livestock operators and oil and gas development personnel, who by definition are not casual observers, would also see the visual impacts in the ARPA, although they would likely be less sensitive to these impacts because they would be working in the area, not there to enjoy it.

Impacts to hydrologic systems and loss of vegetation would alter the character of the visual setting present in the ARPA. The proliferation of weeds on disturbed soils would further alter the setting and inhibit the success of reclamation.

In conclusion, the visual contrast introduced into the ARPA by the Proposed Action would be high. This level of contrast exceeds the maximum allowable in VRM Class III (96 percent of the ARPA) and is allowable in VRM Class IV (only 4 percent of the ARPA). Therefore, based on the criteria presented in table 4-8, the impact of the Proposed Action as a whole to visual resources of the ARPA would be high, and thus significant. Impacts to visual resources from the Proposed Action would be long term, beginning during development and lasting beyond the life of the project. In addition, the Proposed Action would potentially leave weak residual impacts in place

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

on the landscape even after final reclamation at the end of the life of the project because of the time it takes for reclaimed areas to return to pre-disturbance vegetative conditions.

4.10.3.2 Alternative A (No Action)

Under this no action alternative, the Proposed Action would not be approved. The ARPA's visual character would continue to be affected by existing facilities, but no new visual impacts would be introduced, nor would management objectives for VRM Class III be exceeded. The level of contrast introduced by the no action alternative would be low, therefore not significant.

4.10.3.3 Alternative C

Some of the development protection measures included in Alternative C, such as limitations on surface disturbance in slopes over 8 percent, vegetation communities with high wildlife values, rare vegetation communities, proximity to water or wetlands, big game crucial winter range, grouse brood-rearing and nesting habitat, silver sagebrush/bitterbrush communities, and soils with high runoff potential would reduce the visual impacts of development. Road density limitations for grouse brood-rearing and nesting habitat and some SMAs along with requirements for prompt interim reclamation, low impact road designs, careful siting of well pads, roads and facilities, and dust abatement techniques would also contribute to the preservation of the visual setting (See appendix L).

As noted in the introduction and in section 4.10.2, impacts to visual resources in the ARPA were determined by assessing the visual contrast that the project would create on the landscape of the VRM Class III rated lands which constitute 96 percent of the ARPA. 67 percent of the federal lands in the ARPA are visible from federal, state or county roads. Therefore seeing development with strong contrast to the natural landscape that dominates the view of sensitive observers is quite probable and most likely unavoidable.

Development protection measures for visual resources under Alternative C would further reduce the visual impact of the project. Low impact road designs would be used in visible VRM Class III areas with less than 5 percent slope (map M-42), which comprise over 26 percent of the federal surface in the ARPA. Other measures to reduce surface disturbance, prevent facility intrusion above the skyline, do reclamation promptly, and maximize pad distance from main roads would also contribute to preservation of the visual character of the area.

Facilities and roads constructed and visible in VRM Class III under Alternative C are expected to not quite dominate the landscape by becoming the primary focus of and holding viewers' attention as seen from the state, county or BLM roads, and would thus be rated as having a moderate level of impact. With an anticipated reduction in short-term surface disturbance of 68 percent, as compared to the Proposed Action, Alternative C is expected to remain within VRM Class III Management Objectives, and impacts are not expected to be significant.

4.10.3.4 Alternative D

Impacts to visual resources under Alternative D would be similar to the impacts described in the analysis of impacts under the Proposed Action (section 4.10.3.1 above). The acreage of the project area that would be disturbed under Alternative D would be less than the acreage anticipated under the Proposed Action, although the pace of development analyzed under Alternative D is the same as for the Proposed Action. The analyses of both alternatives assumed that operators' reclamation efforts would be successful.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

In conclusion, the visual contrast introduced into the ARPA by Alternative D would be high. This level of contrast exceeds the maximum allowable in VRM Class III (96 percent of the ARPA) and is allowable in VRM Class IV (only 4 percent of the ARPA). Therefore, based on the criteria presented in table 4-8, the impact of Alternative D as a whole to visual resources of the ARPA would be significant. Impacts to visual resources from Alternative D would be long term, beginning during development and lasting beyond the life of the project. In addition, Alternative D would potentially leave weak residual impacts on the landscape even after final reclamation at the end of the life of the project because of the time it takes for reclaimed areas to return to pre-disturbance vegetative conditions and because some improved roads would likely be left in place.

For more information on the visual resources of the ARPA, see the following sections:

• **Visual Resources:** This section describes the visual resources of the ARPA, including the natural and cultural resources that are visible from the ARPA. It also describes the visual resources that are visible from the ARPA, including the natural and cultural resources that are visible from the ARPA. This section also describes the visual resources that are visible from the ARPA, including the natural and cultural resources that are visible from the ARPA.

Figure 4-8. Layer Colorized for Visual Resources

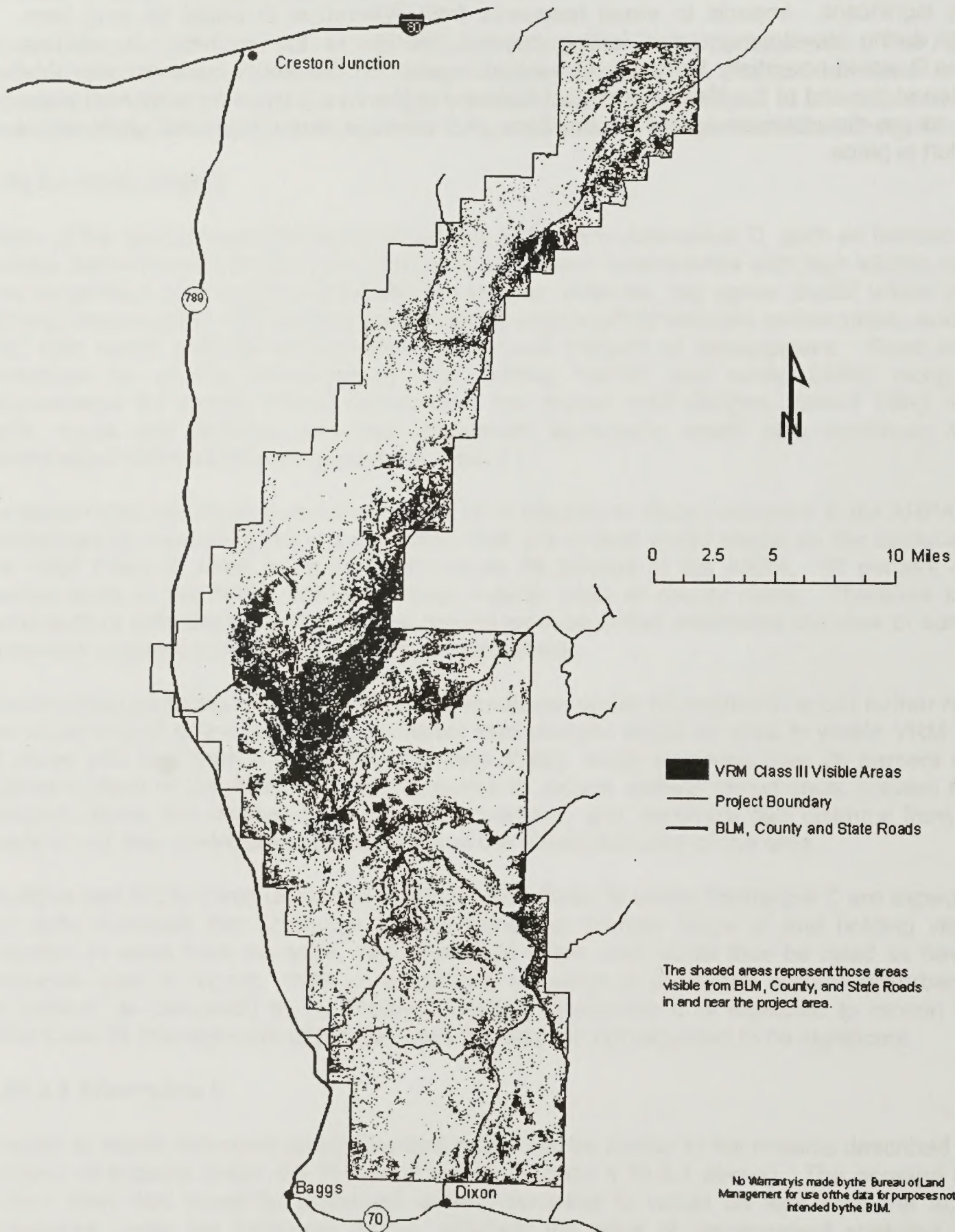


Visual Resources: This section describes the visual resources of the ARPA, including the natural and cultural resources that are visible from the ARPA. It also describes the visual resources that are visible from the ARPA, including the natural and cultural resources that are visible from the ARPA. This section also describes the visual resources that are visible from the ARPA, including the natural and cultural resources that are visible from the ARPA.

Visual Resources: This section describes the visual resources of the ARPA, including the natural and cultural resources that are visible from the ARPA. It also describes the visual resources that are visible from the ARPA, including the natural and cultural resources that are visible from the ARPA. This section also describes the visual resources that are visible from the ARPA, including the natural and cultural resources that are visible from the ARPA.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-42. Areas Visible from Main Roads in VRM Class III with Slopes <5%.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.10.4 Summary of Impacts

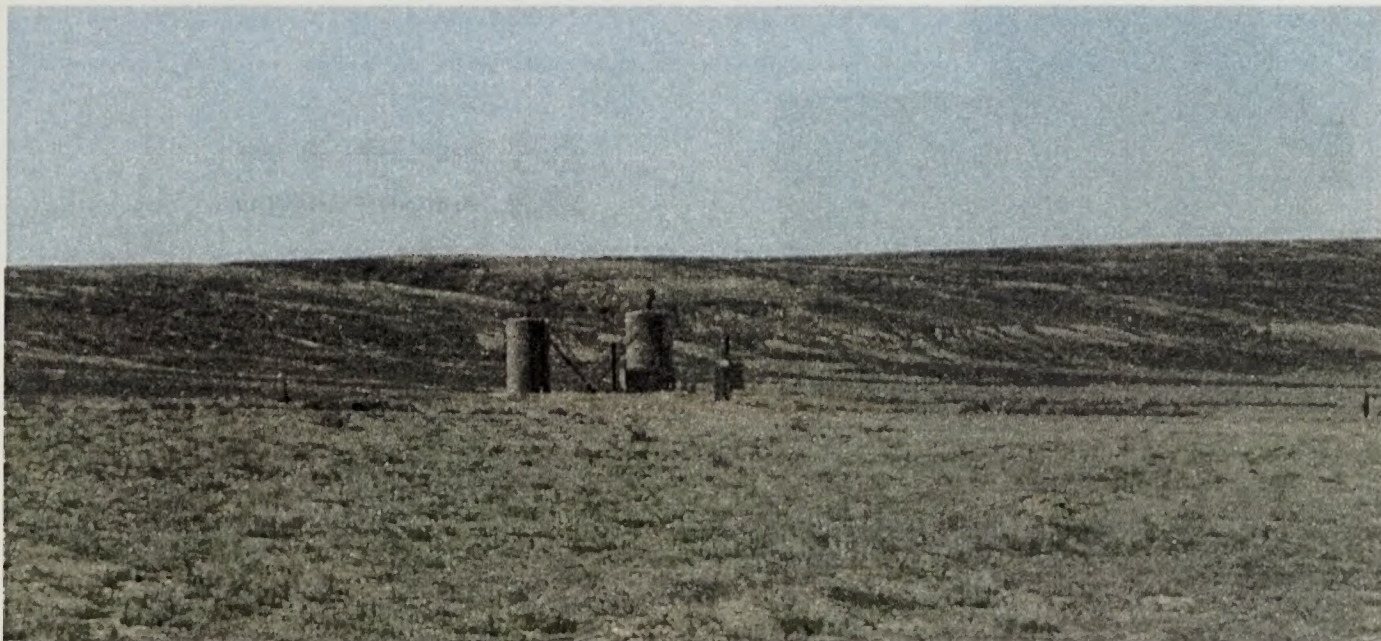
Predicted change to the characteristic landscape for each action alternative is expected to be equal to or greater than the level acceptable under VRM Class III management objectives. The visual quality of the project area would be affected until successful final reclamation and repopulation of mature native shrub communities. The project area would potentially retain numerous improved project roads, which would create lasting linear features that detract from the existing character of the area.

4.10.5 Additional Monitoring and Mitigation Measures

No additional mitigation measures are necessary under the no action alternative.

BMPs are warranted in an attempt to keep impacts within the level allowable on VRM Class III lands. In addition, they may reduce conflict in the long run between continued expansion of mineral development and the interests of other users of the ARPA. Shale green facility coloration would blend satisfactorily with the environment in most well locations (approximately 93 percent of the ARPA or 92 percent of the federal surface within the ARPA) as seen above. Areas that would instead require a brown coloration (approximately 7 percent of the ARPA or 8 percent of the federal surface within the ARPA) to blend with brown shrubbery and grasses are shown on map M-43).

Figure 4-4. Proper Coloration for Visual Resource Management Mitigation.

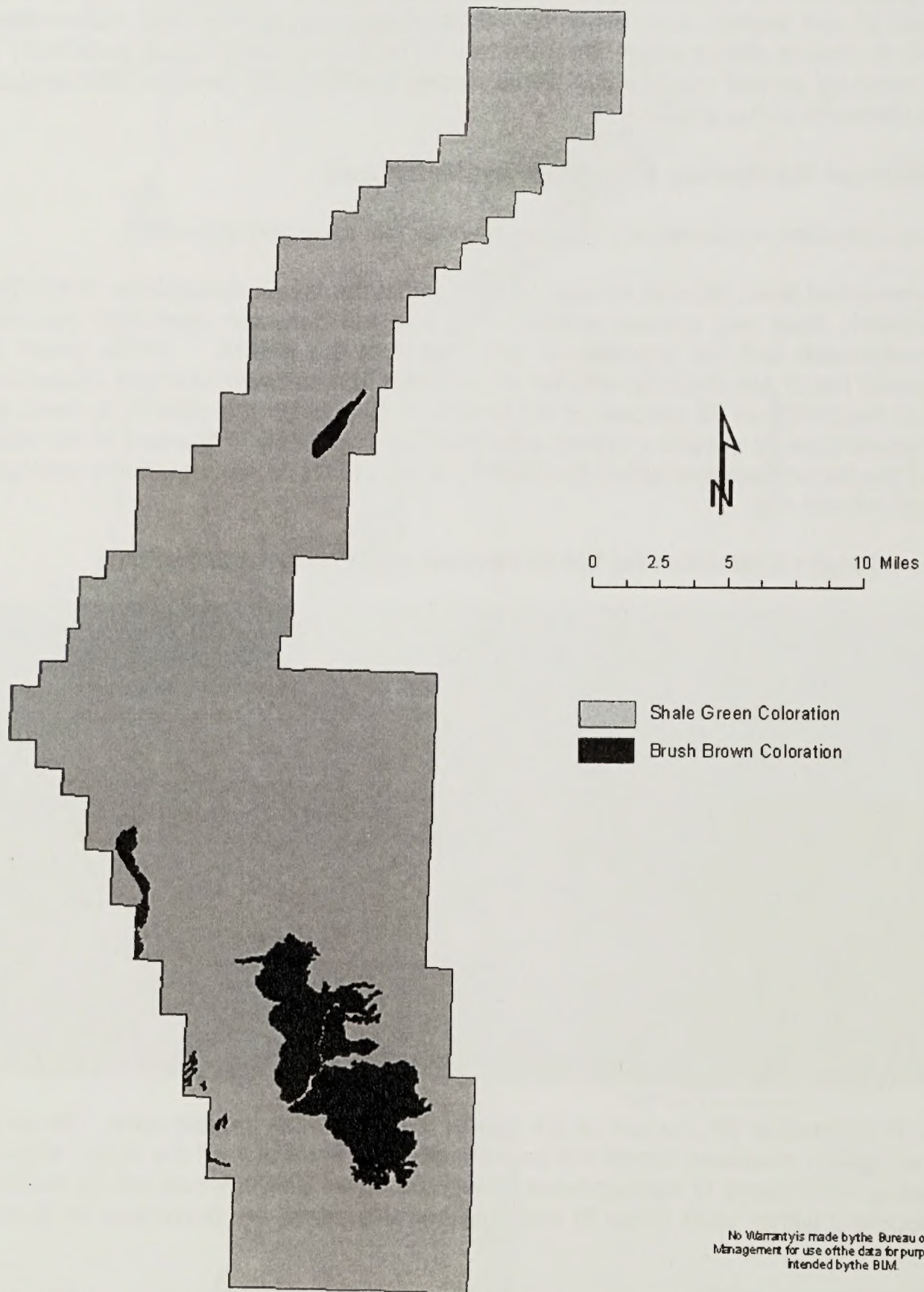


VRM Class III comprises 94 percent of the federal surface in the project area. The operator-committed mitigation measures would not be sufficient to prevent any of the action alternatives from exceeding VRM Class III management objectives. Even BMPs would not be sufficient to keep development within VRM Class III management objectives, as prescribed in figures 4-5 and 4-6.

Alternative C is anticipated to have the maximum visual impact allowable under VRM Class III management objectives, assuming BMPs and additional protections afforded other programs prevent the project from dominating the viewshed. Thus Alternative C would have a moderate visual impact.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Map M-43. Project Area Facility Coloration.



Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

The need for more effective mitigation on all wells is an emerging issue in the GDRA. Although visual sensitivity is not the highest priority for some residents and visitors, a heightened awareness of scenic values and of the existing scenic quality is occurring for some residents and visitors as increasing numbers of sightseers and persons seeking various types of recreational opportunities pass through GDRA lands, including the ARPA.

Figure 4-5. Excerpt from Land Use Planning Handbook.

The Land Use Planning Handbook H-1601-1 (03/11/05) provides the following guidance:

I. Visual Resources

Implementation Decisions. Manage resource uses and management activities consistent with the VRM objectives established in the land use plan. Design all BLM resource uses, management activities, and other implementation decisions to meet VRM objectives established in the land use plan. Utilize visual resource management techniques and best management practices to mitigate the potential for short- and long-term impacts. Contrast ratings are required for all major projects proposed on public lands that fall within VRM Class I, II, and III areas which have high sensitivity levels (see Handbook H-8341-1 for contrast rating procedures).

Figure 4-6. The Visual Contrast Rating Worksheet, Form 8400-4, for the Project would be filled out after an alternative is selected.

Form 8400-4
(September 1987)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date _____
District _____
Resource Area _____
Activity (program) _____

SECTION A. PROJECT INFORMATION

1. Project Name _____
2. Key Observation Point _____
3. VRM Class _____
4. Location
Township _____
Range _____
Section _____
5. Location Sketch _____

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM			
LINE			
COLOR			
TEXTURE			

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM			
LINE			
COLOR			
TEXTURE			

SECTION D. CONTRAST RATING ☐ SHORT TERM ☐ LONG TERM

I. DISCREPANCY OR CONTRAST	FEATURES												2. Does project design meet visual resource management objectives? ☐ Yes ☐ No (Explain on reverse side)	3. Additional mitigating measures recommended? ☐ Yes ☐ No (Explain on reverse side)
	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)					
	Form	Line	Color	Texture	Form	Line	Color	Texture	Form	Line	Color	Texture		
Form														
Line														
Color														
Texture														

Evaluators' Names _____ Date _____

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.11 Cultural Resources

4.11.1 Introduction

Cultural resources on public lands, including archaeological sites and historic properties, are protected by various laws and regulations, for example the National Historic Preservation Act of 1966 (NHPA) as amended, Governing Regulations, and 36 CFR 800. Laws and regulations concerning cultural resources stipulate that the federal government take into consideration the effects of an action on significant cultural resources. This requires that cultural resources within the proposed area of potential effect must be identified and evaluated. A determination of effect is made and measures are then formulated to mitigate or minimize any effects to those historic properties included in, or eligible for, the NRHP.

The ARPA database contains at least 423 cultural resource sites, as summarized in section 3.11. Site types include prehistoric camps including burial, habitation, ceramic/pottery, stone circles, rock shelters, petroglyphs, ground stone/milling activities, and quarries. The prehistoric lithic debris sites include debris scatters/procurements, ceramics, ground stone/milling activities, and quarries.

Historic sites include: trails, stage stations, inscriptions, cairns, debris/trash, ranches, irrigation ditches, ranching/herding/corrals, and a post office. Historic trails include: the Overland Trail, the Cherokee Trail, and the Rawlins to Baggs Road. The Washakie Station (listed on the NRHP) and the Sulphur Springs Stage Station were stops along the Overland Trail. The Sulphur Springs Station was also utilized by the Rawlins to Baggs Road. Other Stage Stations documented in the ARPA associated with the Rawlins to Baggs Road include Muddy Bridge Station and Willow Station. The JO Ranch is a prominent eligible property within the project area.

Prehistoric/historic sites are characterized as prehistoric camp/historic debris scatters or lithic scatters/historic debris scatters. Of the 423 sites recorded in the EIS analysis area to date, 32 percent are recommended eligible (n=135) for nomination to the NRHP, 34 percent are recommended not eligible (n=145), and 34 percent remain unevaluated (n=143). Before 2003, approximately 20 percent of the area had been inventoried at a Class III level and site density is projected to be 0.008 sites per acre. Certain topographic settings have greater archaeological sensitivity including eolian deposits (sand shadows and sand sheets) and, to a limited degree, colluvial deposits along lower slopes of ridges. Sensitive areas include drainages, such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek, and Deep Creek along with their tributaries. The numerous springs in the area would likely be associated with cultural resources.

The BLM has designated a quarter-mile buffer surrounding the contributing segments of the historic trails and associated sites as highly sensitive and would result in the exclusion of disturbance of approximately a maximum of 20,583 acres in order to protect the physical remains. The number of acres excluded from development would possibly be less as contributing segments of the Cherokee Trail are determined upon final acceptance of the inventory. For management purposes, the BLM has established a two-mile analysis area around the trails for consideration of the elements of setting as defined as those elements of integrity of location, feeling, and association that contribute to the eligibility of the trails or associated sites. While two miles is the standard distance for consideration of setting, it does not preclude the consideration of a larger area, depending on the circumstances.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.11.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and State (WSLUC 1979) land use plans prescribe the following management objectives associated with cultural resources:

- To protect and preserve representative samples of the full array of cultural resources for the benefit of scientific and socio-cultural use by present and future generations;
- To ensure that cultural resources are given full consideration in all land-use planning and management decisions;
- To manage cultural resources so that scientific and socio-cultural values are not diminished, but rather are maintained and enhanced; and
- To ensure that the BLM's undertakings avoid inadvertent damage to cultural resources both federal and nonfederal.

Impacts are considered significant if management actions result in effects to properties listed or determined eligible for listing on the NRHP or considered important to Native American groups as measured by:

1. Destruction or alteration of all or part of a property;
2. Isolation of a cultural resource from, or alteration of, its surrounding environment;
3. Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting; and
4. Neglect and subsequent deterioration.

Significance, under NEPA, is detailed in 40 CFR 1508.27 and is distinct from archeological significance. Cultural resource significance is measured by four categories defined by the Code of Federal Regulations (36 CFR 60.4):

"...the quality of significance in American history, architecture, archaeology, and culture present in districts, sites, buildings, structures and objects of state and local importance that possess integrity of location, design setting, materials, workmanship, feeling, and association; and that:

- A. Are associated with events that have made a significant contribution to the broad patterns of our history; or
- B. Are associated with the lives of persons significant in our past; or
- C. Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- D. Have yielded, or may be likely to yield information important in prehistory or history. (36 CFR 60.4)"

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

For cultural sites, both prehistoric and historic, significance is primarily judged either by the site's ability or potential to yield information important in prehistory or history (criterion D) or the site's association with events that have made a significant contribution to the broad patterns of our history (criterion A). Each site's importance, however, is determined individually, so the existence of sites eligible under criteria B or C must not be discounted.

The BLM meets its responsibilities under Section 106 of the NHPA through the implementation of a national Programmatic Agreement among the BLM, the Advisory Council on Historic Preservation (ACHP), the National Conference of State Historic Preservation Officers, and a state protocol with the Wyoming State Historic Preservation Office (SHPO) rather than by following the procedure set forth in the ACHP's regulations (36 CFR Part 800).

The preferred strategy of cultural resource management is avoidance of affect to those elements that contribute to the eligibility of a historic property. If this strategy cannot be implemented, mitigation of effects by project redesign, data recovery, project cancellation, or numerous other mitigation options should be implemented.

4.11.3 Direct and Indirect Impacts

4.11.3.1 Proposed Action

At the Proposed Action's rate of disturbance, if the density of site types is predicted at 0.008 sites per acre, it is estimated 126 sites could be disturbed. Of those, 32 to 40 percent could be eligible for the NRHP. These calculations assume that the area-wide site density is equal across the ARPA and that the 20 percent area inventoried is a valid sample.

Direct impacts would primarily take the form of alteration or disturbance of previously unidentified sites. Physical disturbance of eligible sites could result from any disturbance activity. Indirect impacts could result from associated erosion resulting from the changes in surface hydrology. In turn, the loss of integrity of surface cultural material or the exposure and degradation of subsurface material and their contexts could be expected. Indirect impacts also would result from the removal of vegetation, which would serve to destabilize the soils and in turn cause additional erosion of site areas. In addition, as access to previously-isolated areas becomes more abundant, the frequency of human intrusion and the possibility of looting also increase.

Where the setting of the trails and associated sites contributes to NRHP eligibility, actions resulting in the introduction of visual elements that diminish the integrity of the property's significant historic features would be a factor.

4.11.3.2 Alternative A (No Action)

Under the no action alternative, the Proposed Action would not be implemented and additional drilling would be allowed on federal lands; however, individual APDs would be approved on a case-by-case basis. No additional impacts to cultural resources could be expected beyond those analyzed in the previous environmental assessments for the Atlantic Rim pods.

4.11.3.3 Alternative C

In general, constraints under Alternative C would focus on surface disturbance limitations: limited operating periods, modification of drilling and construction practices, and in some cases

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

no surface occupancy/disturbance. Under this alternative, sensitive cultural resource areas would be eliminated from development or be subject to extensive mitigation measures. Direct impacts of sites not visible during inventory (discovery situations) would be the same as with the Proposed Action. A by-product might be the reduction of indirect effects resulting from unauthorized collection of cultural material due to lower access into the area.

4.11.3.4 Alternative D

Direct and some indirect impacts to cultural resources could be expected to occur at a lower rate and intensity than the Proposed Action due to the reduced disturbance goal of 20 percent. Impacts to historic setting would be lessened in direct correlation to the success of vegetation reclamation/restoration.

4.11.4 Impacts Summary

Gauging the effect of any impact depends on the level of information available for that particular property provided by inventory or testing data. If cultural resources on or eligible to the National Register are to be adversely impacted by the proposed undertaking, the applicant, in consultation with the surface managing agency and the SHPO and with input from other interested parties per 36 CFR Part 800.6 and the Statewide Protocol Section VII, shall develop a mitigation plan designed to eliminate the adverse effects. Construction would not proceed until the terms of the mitigation plan are satisfied. Impacts to historic properties from projects occurring in the absence of a federal undertaking (federal authorization) would be beyond federal control.

4.11.5 Additional Mitigation Measures

The additional mitigation measures apply to all alternatives because the primary focus of effects to cultural resources is based on location and secondly the extent of the surface disturbance. None of the alternatives propose significant development modifications; therefore, impacts to cultural resources would be similar under all the alternatives.

Additional mitigation measures may include, but are not limited to, the following measures listed below. These measures will be incorporated into an agreement or agreements established under the Wyoming state cultural resources protocol. BLM will seek to establish a programmatic agreement between the BLM, SHPO, project proponents and interested parties that will address site-specific impacts and mitigation measures for all sites where setting contributes to NRHP eligibility.

Common to All Alternatives:

Mitigation of Direct Impacts:

- Construct smaller well pads,
- Construct narrower roads,
- Construct multiple well locations per pad to decrease the total acres of disturbance,
- Brush hog ROWs,

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

- Allow no surface disturbance within a quarter mile of contributing segments of historic trails or trail-associated sites, and
- Limit trail crossings to existing disturbance corridors or non-contributing segments, unless otherwise determined by BLM in consultation with SHPO.

Mitigation of Impacts to Setting Where Contributory to Eligibility:

- Begin reclamation at the time most optimal to regenerate the native species,
- Replace native shrubs to decrease visibility,
- Construct roads in minimally visible areas,
- Relocate project or hide disturbance, and
- Use matting on ROWs during construction to minimize surface disturbance and visibility.

4.12 Socioeconomics

4.12.1 Introduction

Implementation of any of the action alternatives or the no action alternative would result in both positive and adverse socioeconomic effects. Positive effects of the action alternatives would include increases in economic activity; income; employment; and local, state, and federal government tax and royalty revenues. Adverse effects of the action alternatives would include disruptions in activities and lifestyles of those who own private land or use public land within the ARPA, including ranchers, grazing operators, hunters, and other recreation visitors. These disruptions could result in effects on the grazing and recreation sectors of the Carbon County economy. Implementation of the no action alternative would avoid the disruption of activities and lifestyles associated with the action alternatives, but would also forego the employment and fiscal benefits associated with these alternatives.

4.12.2 Impact Significance Criteria

The following criteria were used to determine whether socioeconomic impacts of the Proposed Action and alternatives would be significant:

1. An increase in county or community population that would strain the ability of affected communities to provide housing and services or otherwise adapt to growth-related social and economic changes;
2. An aggregate change in revenue and expenditure flows likely to result in an inability on the part of affected units of government to maintain public services and facilities at established service levels;
3. Permanent displacement of residents or users of affected areas that would result from project-induced changes in or conflicts with existing uses or ways of life; or

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4. Disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population, which appreciably exceed those to the general population around the project area.

4.12.3 Direct and Indirect Impacts

Socioeconomic effects can cover many topics. In this section, the following impacts are analyzed under each alternative:

- Economic effects;
- Alternatives-related effects on other economic activities within the ARPA;
- Employment and population effects;
- Housing effects;
- Effects on community services;
- Fiscal effects;
- Local attitudes, opinions, and lifestyles; and
- Environmental justice.

4.12.3.1 Proposed Action

Economic Effects

The Proposed Action, as described in chapter 2 of this assessment, would involve an estimated \$2.1 billion capital investment for drilling, completion, gathering systems, and field infrastructure, excluding the investment for the interim drilling period. This investment would occur over 20 years.

Development and operation of the Proposed Action would require goods and services from a variety of local, regional, and out-of-state contractors and vendors in the oil and gas service industry and other economic sectors. Expenditures by the operators for these goods and services, coupled with subsequent employee and contractor spending of earnings and profits, would generate the economic effect of increased income in southwestern Wyoming, the State of Wyoming, and the nation as a whole. These effects could be reduced in magnitude by Proposed-Action-related reductions in other economic sectors, primarily those that include grazing and outdoor recreation (primarily hunting), as discussed in the next subsection.

For this assessment, infrastructure and production estimates provided by the operators were used as inputs for a regional economic modeling process using the IMPLAN economic modeling software. IMPLAN is an input-output-based model originally developed to assist the USDA-FS in land resource management planning. Subsequently, the model and related software were transferred into the private sector, where it is the subject of ongoing refinement and enhancements to provide the analytical capacity to address a broader range of economic and impact planning issues. IMPLAN is widely recognized and accepted in regional economic and economic impact assessment circles. The model maps the flow of dollars through the region's economy and provides information about the interaction of individual sectors within the regional economy. The model considers both the direct effects on the producing sector(s) of a change in economic activity and the secondary effects on other local sectors due to the linkages within the region's economy. The model was used for the socioeconomic portion of the BLM's Southwest Wyoming Resource Evaluation (UW 1997) and for a variety of other NEPA assessments and BLM planning initiatives including the current revisions to the Rawlins RMP.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

IMPLAN is a static model that assumes that current relationships between sectors will remain similar in the future. The model does not consider changes in other sectors of the economy unless they are also specified as inputs. For this assessment, only the economic activity associated with the Proposed Action was considered in the IMPLAN modeling process. As noted, the activities associated with the Proposed Action have the potential to affect other economic activities, such as reduced grazing and outdoor recreation within the ARPA. These potential effects are not addressed within the IMPLAN modeling process but are discussed below in the following subsection.

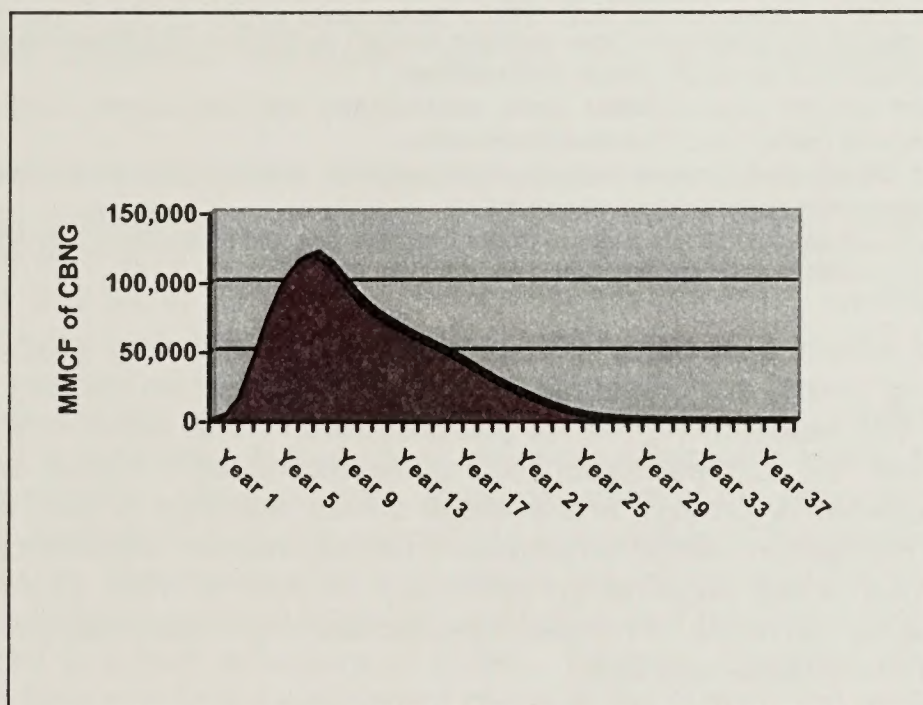
The model calibration and other elements of this assessment are based on the following assumptions:

- Drilling and field development in the ARPA would occur over 20 years (figure 2-1), during which a total of 1,800 CBNG wells would be drilled, in addition to the 116 wells drilled during the interim drilling period (The model assumes a success rate of 100 percent). For the purposes of this assessment, it is assumed that 200 conventional wells would also be drilled, also with a success rate of 100 percent.
- The operators estimate that each CBNG well would produce about 750,000 thousand cubic feet (MCF) of natural gas over 13 years (figure 4-7). Under the Proposed Action, some wells would be drilled late in the 20-year assessment period; therefore, production could continue for 13 years after the 20-year drilling and field-development period ends.
- Although there are existing conventional gas wells within the ARPA, the operators have not estimated production associated with the conventional wells included in this assessment. Omitting production estimates for conventional wells may understate long-term economic, employment, and fiscal benefits of production if drilling efforts in conventional formations meet with substantial success. However, because the employment and population effects of production would be substantially lower than employment and population effects of drilling and field development, which are included, the assessment would not understate socioeconomic effects.
- Each CBNG well would require an average of \$633,000 to drill and complete; an additional per well average of \$379,000 would be spent on gathering and electrical systems, gas line laterals, compressor stations, and injection facilities. Wells drilled to deeper conventional targets would be drilled with essentially the same equipment although completion and production techniques would differ. Consequently, conventional well costs are assumed to be approximately 50 percent higher than CBNG well costs.
- For the purpose of the assessment, wells would be drilled according to the schedule presented in figure 2-1.
- Only a portion of the expenditures in each category would occur within southwest Wyoming; other materials and labor purchases would occur elsewhere in Wyoming or out of state. Estimates of local and non-local expenditures have been developed for each drilling and field development category (e.g., rig costs, labor costs, fuel costs, and pipe costs) based on actual AEPC expenditures during the interim drilling period.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

- Revenues, expenditures, and economic effects are expressed in terms of constant 2004 dollars.
- Annual average wellhead gas prices are based on the \$4.25 per MCF estimate for gas prices beyond 2005 contained in the October 2004 Wyoming Consensus Revenue Estimating Group Wyoming State Government Revenue Forecast (CREG 2004). These are likely conservative estimates. Note that CREG increased wellhead price estimates for natural gas to \$6 per MCF for 2006 and beyond in October 2005. Spot prices at Wyoming hubs were over \$10 per MCF during the fall of 2005 as a result of hurricanes Katrina and Rita.

Figure 4-7. Estimated Project-Related Coal Bed Natural Gas Production.



Note:

Excludes production from the Interim Drilling Program.

Source: AEPC 2004.

Use of the foregoing assumptions and the IMPLAN model allow a reasonable but conservative assessment of the economic impacts of the Proposed Action; however, economic effects of all action alternatives would be different than those forecast by the model if actual conditions vary substantially from these assumptions.

Estimated economic effects of Proposed Action drilling and field development are displayed in table 4-10. Based on the foregoing inputs and assumptions, an estimated annual average direct regional expenditure of about \$49 million would result in an annual economic impact of about \$62 million in southwest Wyoming, or a total economic impact of almost \$1.2 billion over the 20-year drilling cycle.

Estimated annual drilling and field development employee earnings in southwest Wyoming would average almost \$22 million or about \$434 million total over 20 years. These earnings would support an average of 578 annual job equivalents (AJEs). AJEs reflect an aggregation of all employees (existing and new) whose employment would be supported in whole or in part by Atlantic Rim project spending. The term AJE is used to emphasize that these are not all

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

discrete or separate new jobs created by the Proposed Action, rather they represent both new and existing jobs and portions of jobs that are wholly or partially supported by the incremental economic activity associated with the Proposed Action.

Table 4-10. Estimated Economic Effects of Drilling and Field Development: Proposed Action.

	Direct Regional Expenditures ¹	Total Economic Impact ²	Total Earnings ³	Employment (AJE) Direct, Indirect & Induced ⁴
Annual Average	\$49 million	\$62 million	\$21.7 million	578
Total	\$981 million	\$1.2 billion	\$434 million	n/a

Notes:

¹Direct regional expenditures are purchases from vendors located in Carbon and Sweetwater counties by the operators and their contractors for labor, goods, and services.

²Total economic impact reflects project-related direct expenditures and subsequent rounds of spending by vendors and employees in Carbon and Sweetwater counties.

³Total earnings reflect wages and salaries paid to direct, indirect, and induced employees associated with Proposed-Action-related drilling and field development.

⁴Direct, indirect, and induced employment is defined under Employment and Population Effects below.

Source: IMPLAN Model results based on information provided by AEPC.

Estimated economic effects associated with production (not including production associated with the interim drilling period) are presented in table 4-11. Based on the assumptions outlined in the earlier part of this assessment, natural gas production would result in \$6.4 billion in total economic impact over the 32-year production cycle (production impact estimates include impacts outside southwest Wyoming), and average annual earnings of \$6.6 million supporting 161 average AJEs. Production-related employment (direct, indirect and induced, as defined in the subsections below) would begin at an estimated 14 AJE in Year 2, increase to 461 in Year 8, and then steadily decrease. Production-related earnings and employment effects would occur in Carbon and Sweetwater counties.

Table 4-11. Estimated Economic Effects Associated with Proposed Action-Related Production.

	Total Economic Impact ¹	Total Earnings ²	Employment (AJE) Direct, Indirect & Induced ³
Annual Average	\$200 million	\$6.6 million	161
Total	\$6.4 billion	\$210 million	n/a

Notes:

¹ Total economic impact is the total economic activity that occurs in the region as a result of production including the direct effect, which represents the dollar value of the industry's production plus the secondary effects of increased business activity for industries that support the industry where the production occurs.

² Total earnings reflect wages and salaries paid to direct, indirect, and induced employees associated with Proposed-Action-related drilling and field development.

³ Direct, indirect, and induced employment is defined under Employment and Population Effects below.

Source: IMPLAN model results based on information provided by AEPC.

As shown in table 4-12, the combined drilling, field development, and production phases of the project would generate an estimated \$7.6 billion in total economic impact, including \$644 million in total earnings in southwest Wyoming over the 40-year life of project used for this assessment.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Table 4-12. Combined Proposed Action-Related Drilling and Production Economic Effects.

	Direct Expenditures¹	Total Economic Impact¹	Total Earnings	Average Annual Employment (AJE) Direct and Indirect)
Total	\$ 6.7 billion	\$7.6 billion	\$644 million	578 drilling /161 production

Note:

¹ Includes impacts outside southwest Wyoming.

Source: IMPLAN model results based on information provided by AEPC.

Proposed-Action-Related Effects on Other Economic Activities within the ARPA

As outlined in section 3.11, existing land uses within the ARPA include wildlife habitat; grazing; hunting and other dispersed recreation; and oil and gas exploration, production, and transmission.

Grazing. The economic assumptions for grazing contained in appendix 35 of the Draft Rawlins RMP estimate that cattle grazing generates \$64.36 per AUM in total economic impact in the region, and results in \$18.77 in earnings/AUM and .000709 jobs/AUM. Each AUM of sheep grazing results in \$42.36 in regional economic impact, \$5.83 in earnings, and generates .0009513 jobs.

Potential impacts to grazing activities and range resources were discussed in section 4.6. In that assessment, it is estimated that grazing use of the allotments in the ARPA is 91 percent cattle and 9 percent sheep. One potential economic effect of the Proposed Action on grazing activities would be reductions in AUMs associated with losses of forage due to temporary and long-term disturbance. The total economic impact of reductions in AUMs associated with initial disturbance (2,026 AUMs) would be \$126,382, assuming that the loss of forage associated with disturbance resulted in actual reductions in AUMs. Because the initial disturbance would be over the 20-year drilling and field development phase of the project, the economic impact would similarly be spread over the life of the project. It routinely takes more than one season for reclaimed areas to become established. Consequently, economic impact associated with initial disturbance would be multiplied for each year required to re-establish forage, again assuming that disturbance resulted in actual reductions in AUMs.

However, the grazing assessment in section 4.6 concludes that the amount of forage lost as a result of Proposed-Action-related disturbance would be less than the normal variations in forage availability from year to year. Therefore, disturbance would be minimal in the short term and may actually increase available forage in the long term because reclaimed vegetation would consist of herbaceous species, which cattle prefer. Consequently, short- or long-term disturbance-related reductions in AUMs for grazing allotments within the ARPA resulting from implementation of the Proposed Action cannot be predicted with certainty.

Some aspects of natural gas development may be useful for grazing operators; for example, improved road access to grazing areas could facilitate livestock management for some operators, reducing costs. Other aspects of development could generate reduced economic impacts to ranchers and grazing operators. Dust could reduce the palatability of forage near disturbed areas, requiring more intensive livestock management practices to ensure adequate forage. Incursion of noxious and invasive species could reduce available forage and require more intensive management practices. Operators may also have to manage livestock more

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

intensively to avoid drilling and field development activity or to retrieve livestock scattered because of unrepaired damage to fences or cattle guards. More intensive livestock management practices would result in increased costs to operators. Unreported vehicle livestock collisions could also result in economic losses for ranchers and grazing operators.

The collective effects of the above impacts could induce some grazing operators to forgo use of their allotments for one or more seasons during periods of intensive development. If withdrawal of cattle were to occur, if these grazing operators could not find comparable grazing lands within the county at comparable costs, or if they chose to forgo grazing entirely for one or more seasons, the economic impact associated with that operator's AUMs would also be forgone. In this case, according to the range assessment in section 4.6, losses associated with BLM allotments could range from 6,000 AUMs, which would generate a loss of \$374,280 in total economic impact, to 12,000 AUMs, a loss of \$748,560. Including both BLM and private lands, reductions in AUMs could range as high as 20,000 AUMs, which would result in a total economic impact of \$1,247,600. The economic impact of reductions in AUMs associated with grazing operators opting to forego use of their allotments would occur each year that cattle are withdrawn from the allotment, assuming that other grazing lands were not available.

If grazing operators were to forgo use of allotments, areas that were reclaimed would have more time to become established, reducing the potential for the spread of weeds. This could provide some economic benefit to grazing operators when they resumed use of the allotment.

Recreation. According to the recreation assessment contained in section 4.9, some hunters and other recreation visitors to the ARPA may be temporarily displaced from the area by drilling, field development activity, land disturbance, and reductions in game. A lesser number of hunters and recreation visitors may be displaced in the long term because of the loss of undisturbed landscapes and solitude. The above-referenced University of Wyoming report provided estimates of per-day total regional economic impact that range from \$156 per day for non-resident hunting, \$159 for non-resident OHV use, and \$51 per day for non-resident general recreation (UW 1997). Estimates of regional jobs associated with these recreation activities range from 0.005/visitor day for non-resident hunting, 0.003 for non-resident OHV use to 0.001 per day for general non-resident recreation.

Estimates of the number of recreation visitors to the ARPA are not available. Estimates of the number of hunters and other recreation visitors who would be displaced temporarily or in the long term by the Proposed Action are similarly not available. Estimates of use of the hunt areas that include the ARPA are presented in section 3.9. Based on these estimates and the total economic impact estimates of non-resident mule deer, elk, and antelope hunting contained in the draft Rawlins RMP, total economic impact of non-resident big game hunting in the hunt areas that contain the ARPA is about \$1.5 million annually. Because the hunt areas are substantially larger than the ARPA, the portion of total economic impact attributable to non-resident hunting within the ARPA is smaller than the above estimate and reductions in hunting would likewise result in economic impacts smaller than the above estimate.

Big game hunting is economically important to communities near the ARPA. A number of landowners within the ARPA provide outfitting services to non-resident hunters and some lease their land to outfitters or allow hunting for a fee. These activities provide additional income for landowners; in years when cattle or sheep prices are low, they provide a substantial portion of total income (Caricco 2005, Hicks 2004, Hansen 2004, and O'Toole 2004). Also motels, RV parks, cafes, convenience stores, and gas stations in the Little Snake River Valley derive a

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

portion of their business from big game hunters (Hicks 2004). Consequently, substantial reductions in big game hunting within the ARPA would result in reduced incomes and have economic effects on landowners, outfitters, and businesses in the Little Snake River Valley. For individual landowners and outfitters, these losses could range from minimal to substantial depending on the location of natural gas development in relation to a specific property, the timing of development, actual effects on big game and big game habitat, climatic conditions, the duration of effects, and the success of mitigation measures. Economic effects to businesses in the Little Snake River Valley could be offset by the economic activity associated with the Proposed Action.

Employment and Population Effects

Employment. Population effects of the Proposed Action would be associated with direct, indirect, and induced employment. Direct employment would include workers in oil and gas service occupations, construction, or other sectors involved in some aspect of Proposed-Action-related drilling, field development, or production. Indirect employment would include jobs and portions of jobs created by industries purchasing from other industries in response to local spending associated with the Proposed Action. Induced employment would be created by employees spending income earned from the Proposed Action, whether from direct, indirect, or induced employment; induced employment would occur across most economic sectors.

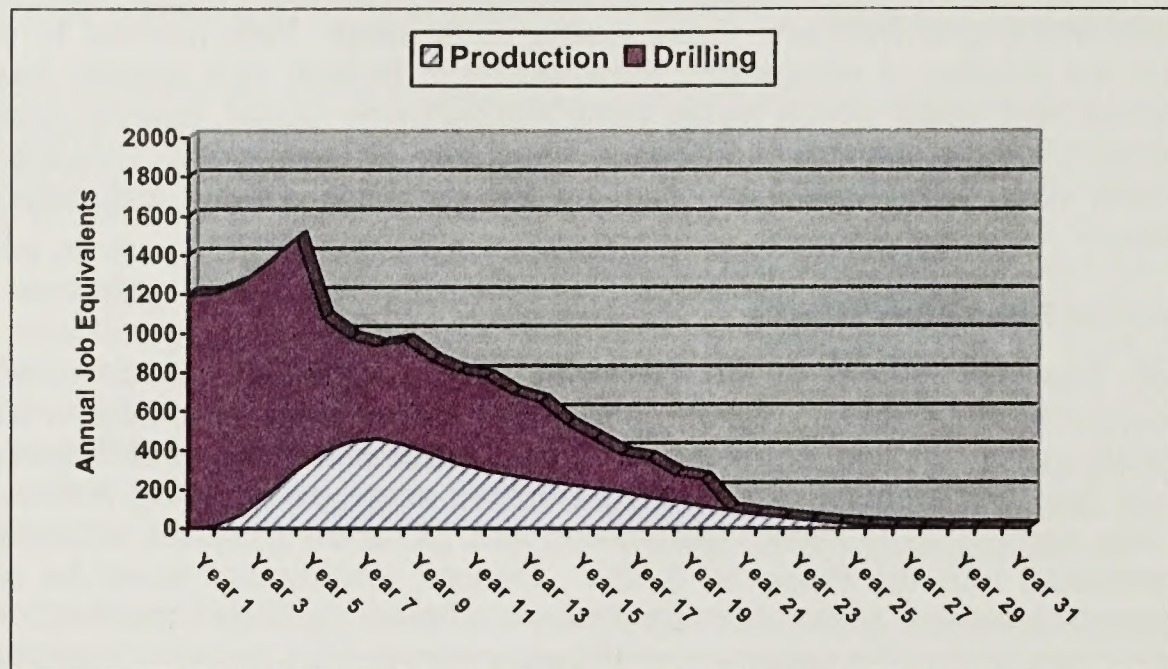
As a result of the Proposed Action, direct, indirect, and induced jobs would be created in Carbon and Sweetwater counties, and would include:

- Temporary jobs, primarily in drilling, natural gas service, and related construction industries. These temporary jobs would be primarily filled by non-local workers who would relocate to the area for the duration of the particular work assignment. To a lesser extent, it would also apply to existing southwestern Wyoming residents. Work assignments can range in length from 6 months to a matter of hours at any one location.
- Existing direct, indirect, and induced jobs, as well as portions of existing jobs that have been supported by natural gas drilling, field development, or production activities in the past and would continue to be supported by these activities under the Proposed Action.
- New jobs and portions of new jobs filled by existing southwestern Wyoming residents or by in-migrant workers who relocate to southwest Wyoming for employment. In-migrant workers are defined as workers who move into the area for project-related employment purposes.

Figure 4-8 displays estimated total employment associated with the drilling/field development and production phases of the Proposed Action.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

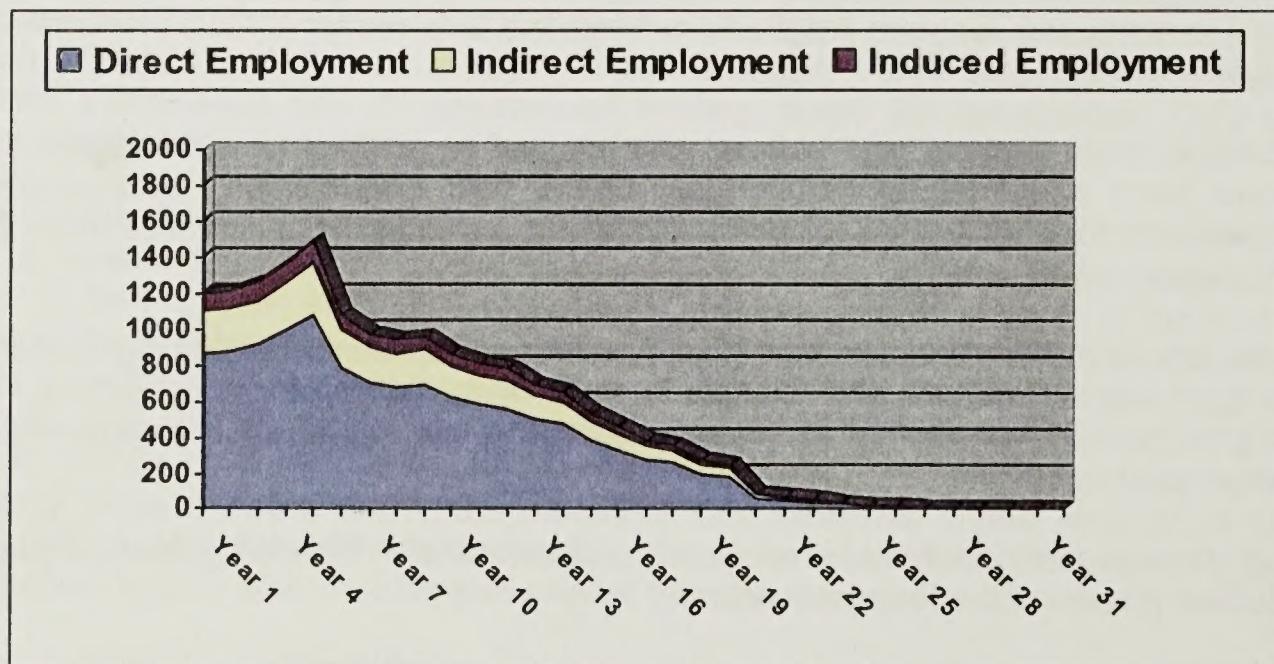
Figure 4-8. Estimated Proposed Action Total Drilling and Production Employment: Direct, Indirect, and Induced.



Source: IMPLAN model results based on information provided by AEPC.

Figure 4-9 displays the direct, indirect, and induced components of Proposed-Action-related employment.

Figure 4-9. Components of Total Proposed Action-Related Employment: Direct, Indirect, and Induced.



Source: IMPLAN model results based on information provided by AEPC, 2004.

Population. Although the employment and income effects of the Proposed Action would be substantial and sustained at a high level of activity for 8 to 10 years, the Proposed Action is likely to result in moderate long-term population growth. A number of factors in the natural gas

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

industry and the local economy would likely intervene to reduce the population effects of the economic stimulus.

Chief among these is the existence of a mature oil and gas service industry infrastructure in southwestern Wyoming. Drilling and field development activities in the ARPA would be performed by a combination of local contractors and regional and national oil and gas service firms, many with local presences in these same communities. Local contractors are primarily located in Rawlins and Rock Springs, and to a lesser extent, the Little Snake River Valley and Wamsutter. Between 1995 and 2004, APDs in Carbon and Sweetwater counties increased over 300 percent. In response to this activity, oil and gas service firms have expanded, particularly in Rock Springs, which is the major oil and gas service center for southwestern Wyoming.

During the 9-year period that drilling activity increased dramatically in the two counties, Carbon County resident population decreased by 5 percent and Sweetwater County resident population decreased by 7 percent. There are several apparent reasons for this phenomenon.

- Many oil and gas drilling and service companies are staffed by employees with primary residences in other parts of the country. These employees relocate to Carbon and Sweetwater counties in single status (i.e., without family members) on a temporary basis. They return to their homes when they are off shift or at the end of their work assignment (Blodgett 2004, Kilgore 2004, and Kot 2004). In some cases, these employees are considered double transients who temporarily relocate to a service company's office in Rock Springs, travel to other communities, stay in motels or RV parks for a matter of days, and return to Rock Springs for another assignment (Blevins 2004). Because of their temporary nature, these employees are often not counted in population estimates even though they generate demand for temporary housing and for some local government services.
- Coal mining, trona mining/soda ash manufacturing, and logging and lumber manufacturing employment decreased in both counties during the period. Some mine and timber industry employees may have obtained work in the oil and gas service industry and some indirect and induced employees may have retained jobs they otherwise would have lost because of economic activity in the oil and gas sector. As a result, increasing oil and gas industry activity may have slowed population decline in the two-county area.
- At the beginning of the accelerated drilling cycle, oil and gas service firms may have had some underutilized capacity and the local labor pool may have supplied a portion of the increased labor demand.
- During the mid-1990s, several major construction projects helped maintain population in Sweetwater County. As these projects were completed, workers left, which contributed to population decline.

Given that the allowable drilling period on public surface in the ARPA is limited in many areas and generally falls within June through October only, it is likely that many drilling and gas field service workers would continue to relocate to Carbon and Sweetwater counties on a temporary, single status basis. This assumption is supported by the fact that school enrollment in Carbon and Sweetwater counties declined by 26 and 29 percent, respectively, during the 9-year period when drilling increased by over 400 percent, indicating that gas service industry workers have

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

not relocated with families. Declines in school enrollment are also a result of declines in other employment and of aging populations in the two-county area. Indications are that school enrollment is beginning to increase in Rawlins and the Little Snake River Valley (Herold 2005, Kilgore 2005).

As noted above, the natural gas service industry in Carbon and Sweetwater counties has expanded considerably over the last several years in response to the increased drilling and field development activity in southwest Wyoming. It would likely be able to accommodate some portion of the activity associated with the Proposed Action with existing infrastructure and labor force. In addition, it is presumed that the local portion of field construction and gas service industry employment was already in place to serve development under the Atlantic Rim pods (about 40 percent of the peak-year of the Proposed Action).

For this assessment, each employment category (direct, indirect, and induced) has been assigned a residency status (non-local temporary, local, and in-migrant) depending on the characteristics of the work, the existing labor pool, and historical labor factors in southwestern Wyoming. The "local" category is further divided into existing employees and the smaller category of new workers. Table 4-13 displays the hiring status factors used for this assessment.

Table 4-13. Hiring Status of Proposed Action-Related Employment.

Employment Category	Non-Local Temporary	Local		In-Migrant
		Existing Employees	New Hires	
Drilling/Field Development				
Direct	50%	30%	5%	15%
Indirect	25%	45%	5%	25%
Induced	0%	75%	10%	15%
Operations				
Direct	0%	20%	30%	50%
Indirect	0%	75%	10%	15%
Induced	0%	50%	35%	15%

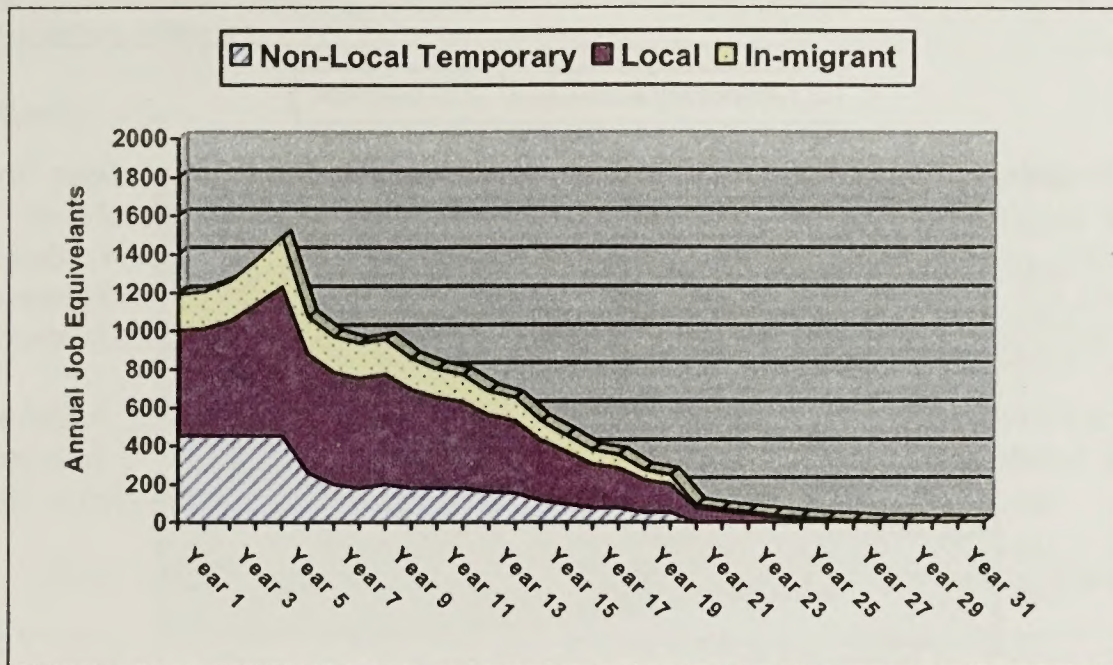
Prepared by: BCLLC

Figure 4-10 displays the estimated non-local temporary, local, and in-migrant components of Proposed-Action-Related employment. During the fifth year of drilling, when an estimated peak of 1,488 direct, indirect, and induced AJEs would be associated with Proposed-Action-related activities, an estimated 453 (30 percent) would be non-local and temporary, 780 (52 percent) would be local, and 256 (17 percent) would be in-migrants. The percentage of locally hired workers reflects the local portion of the 40 percent of the drilling and field development workforce that has been working on the Atlantic Rim pods.

The distinction between non-local temporary, local, and in-migrant workers is useful because each would have different population implications and different demands for community services.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Figure 4-10. Components of Proposed Action-Related Employment.



Note:

Local category includes both existing workers and new hires.

Prepared by: BCLLC

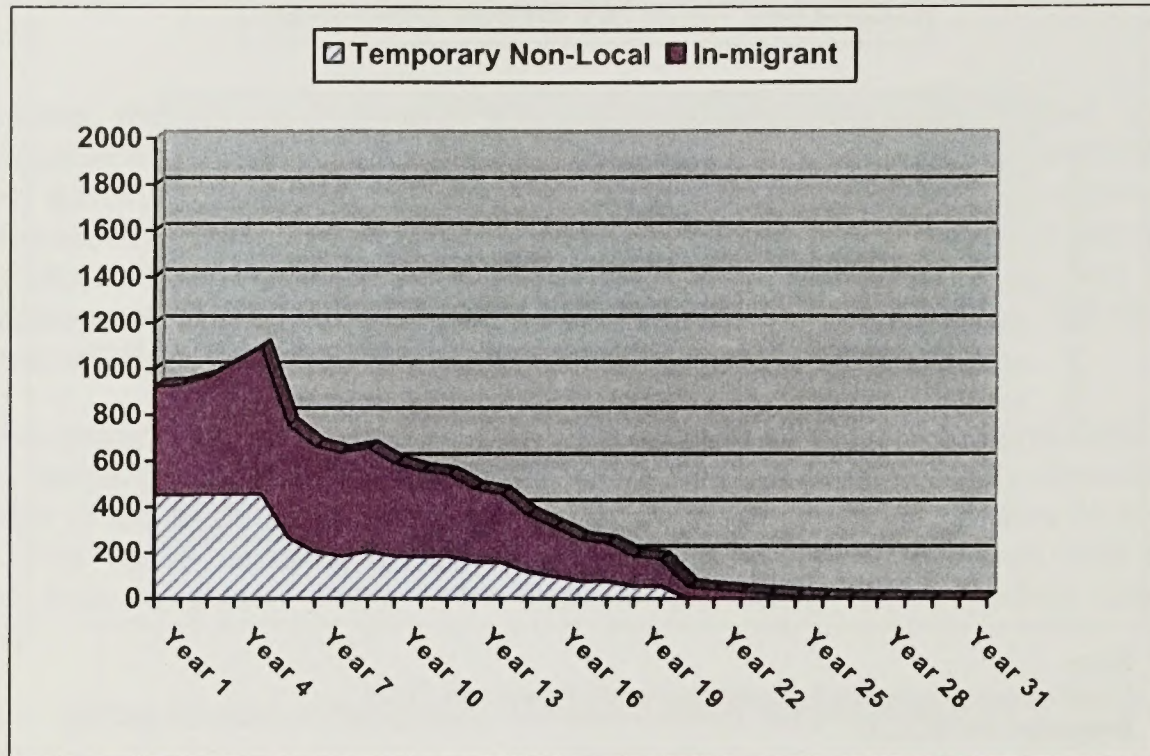
For this assessment, temporary non-local workers are assumed to relocate to southwestern Wyoming in single status, during a limited drilling season each year. Local workers are assumed to be currently living and working in southwestern Wyoming. In-migrant workers are assumed to relocate to southwestern Wyoming bringing an average household size of 2.5 persons, the average household size for the State of Wyoming at the time of the 2000 census. Based on these assumptions, the Proposed Action would result in a peak of 456 additional non-local temporary workers during the Year 1 through Year 5 and a peak in-migrant population of 1,096 during Year 5 of the Proposed Action (See figure 4-11).

The Proposed-Action-related population has been distributed to Rawlins (80 percent), Baggs and Dixon in the Little Snake River Valley (just over 10 percent), and Wamsutter (just under 10 percent) based generally on the size of the community, proximity to the ARPA, and available housing. Using these percentages, Rawlins would receive a Proposed-Action-related population increase of 873 persons (362 temporary and 511 longer term) during the peak (Year 5), Baggs and Dixon would receive a total of 113 (49 temporary and 64 longer term), and Wamsutter would receive a total of 109 (45 temporary and 64 longer term) (figure 4-12). It is important to note that these numbers are in addition to the population associated with existing direct, indirect, and induced workers.

Based on the above population estimates and the percentage of total population enrolled in school during 2000, an estimated 92 school-age children associated with the Proposed Action would be enrolled in schools in Rawlins during the peak year, 11 in the Little Snake River Valley, and 12 in Wamsutter.

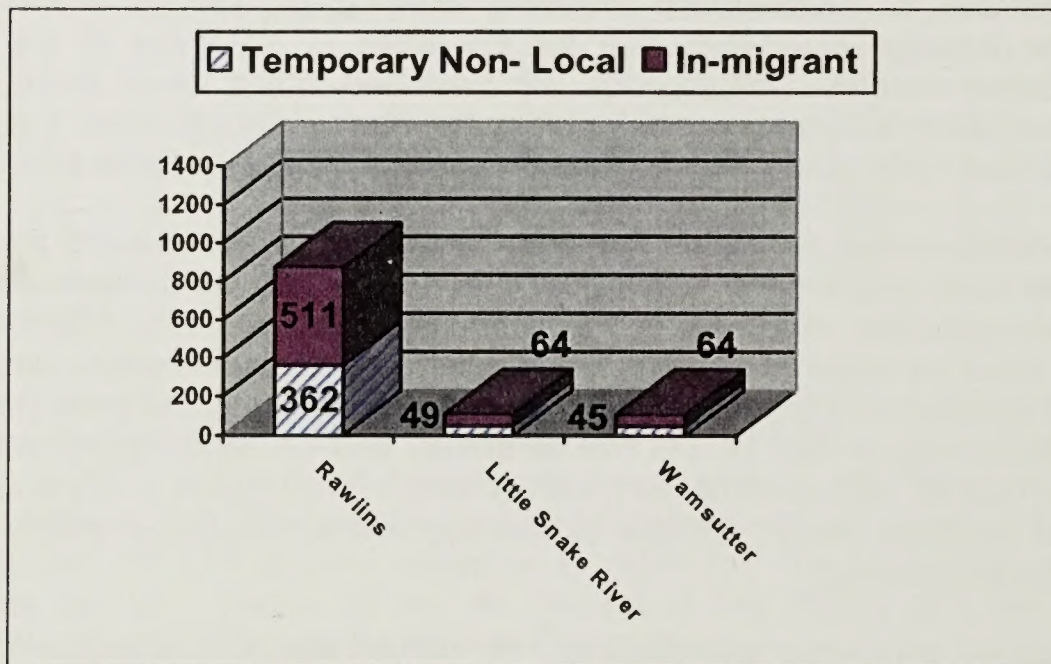
Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Figure 4-11. Proposed Action-Related Peak, Temporary, Single-Status and In-migrant Population.



Prepared by: BCLLC

Figure 4-12. Distribution of Peak Proposed Action-Related Population to Communities.



Prepared by: BCLLC

The Wyoming Division of Economic Analysis projects that Rawlins, Baggs, Dixon, and Wamsutter would have small decreases in population over the next several years (WDAI 2004c). If these projections are correct, the population associated with the Proposed Action may reduce population loss in these communities. However, it is more likely that the anticipated high levels of natural gas development in southwest Wyoming may result in higher total population gain. An increase is particularly likely in Wamsutter, which may gain in

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

temporary short-term population during the construction of two interstate pipelines and the development of a worker housing facility by BP America (See chapter 5 for a discussion of potential cumulative effects).

Housing Effects

First year and peak-year housing demand associated with the Proposed Action is displayed in table 4-14. Non-local temporary workers are anticipated to share housing at a rate of two workers per unit. For longer term housing demand, it is anticipated that every household would include an average of 1.2 workers and have an average size of 2.5 persons, the average size of Wyoming households identified by the 2000 U.S. Census (U.S. Census Bureau 2004).

As with population, it is important to note that the housing demand does not include housing currently occupied by existing workers whose employment would be supported by Proposed-Action-related activities.

Table 4-14. First Year and Peak-Year Proposed Action-Related Housing Demand.

	Proposed Action-Related Housing Demand by Community					
	Rawlins		Little Snake River Valley		Wamsutter	
	1 st Year	Peak Year	1 st Year	Peak Year	1 st Year	Peak Year
Temporary	181	181	23	24	23	23
Longer Term	125	170	16	21	16	21
Total	306	351	39	45	39	44

Prepared by: BCLLC

Based on the housing inventory contained in section 3.12, the Proposed Action-related increment of demand for both short-term and longer-term housing would likely strain or exceed currently available resources in all communities within the analysis area when coupled with demand from other gas development projects.

Based on capacity, the motels, recreational vehicle parks, and mobile home parks could adequately accommodate demand from temporary workers. However, competition from cumulative natural gas development would likely create the need for temporary dormitory housing depending on the level of activity occurring at the time (See chapter 5 for a discussion of cumulative housing demand). It is becoming increasingly common for drilling and gas field service companies to provide mobile dormitory units for temporary workers. Such units add to a community's temporary housing resources without creating an oversupply of units when drilling and field development are completed.

A portion of the longer-term population associated with the Proposed Action could be accommodated in mobile home parks in Rawlins. However, demand from other projects may cause competition for these resources. Rawlins has some currently unused pads in mobile home parks and may initially attract both temporary and longer-term workers. Rawlins might also attract these workers because much of the initial development would likely occur in the central and northern parts of the ARPA. Longer-term workers may relocate to Little Snake River Valley and Wamsutter, as development moves to the southern portion of the ARPA.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Longer-term housing availability is currently tight in both Wamsutter and the Little Snake River Valley. The longer tenure of the relatively small increment of housing demand would allow time for local housing markets to respond to demand for rental or owner-occupied housing units. But it may be that some Proposed-Action-related workers would initially seek housing resources in mobile home parks in Rawlins and either wait for housing to become available in the Little Snake River Valley or Wamsutter or contract for development of new housing.

Effects on Community Services

As discussed in section 3.12, most community facilities in Carbon County and the communities near the ARPA were developed for a substantially larger population than currently exists. As a result, the population increase associated with the Proposed Action could be readily accommodated by most existing community facilities and schools. The enrollment increment in Rawlins could strain the elementary school capacity if Proposed-Action-related enrollment was concentrated in the lower grades. However, enrollment would be adequate if evenly distributed due to the excess capacity in the middle and high schools. In addition, Rawlins should have a new elementary school and should have completed remodeling of the middle school by the time the peak year occurs.

The additional water supply that the recently completed High Savery reservoir provides to Baggs, Wyoming, would accommodate the relatively small population increment projected for that community. A new Carbon County jail has recently been completed, which should alleviate inmate overcrowding, at least for the near term. Some project-related tax revenues associated with the Atlantic Rim pods would be available to offset increased service demand. However, there would be a several-year lag before substantial Proposed-Action-related revenues flow because ad valorem property taxes would provide the largest source of project-related revenue. Given recent increases in natural gas production from other fields and elevated natural gas prices, Carbon County and affected special districts may have substantial revenues to address the increase in service demand associated with the Proposed Action until production-related revenues begin to flow.

Law enforcement, emergency response (fire suppression and ambulance), and county roads are the local government services most likely to be affected during the annual 6-month drilling and field development season. As demonstrated below under Fiscal Effects, Carbon County would receive substantial revenues to help support increased demand for these services over the life of the project.

Although demands on local government facilities and services in Rawlins is anticipated to be moderate and demands in smaller municipalities, minimal, communities would receive few direct revenues from Proposed-Action-related development or production. Therefore impacts that result in demand for new infrastructure or services are unlikely to be offset by Proposed-Action-related revenues. Wamsutter is located in Sweetwater County and would therefore receive no project-related tax revenues, except a small portion of severance tax revenues distributed to local governments throughout the state.

Fiscal Effects

The Proposed Action would generate substantial tax revenues including:

- Local ad valorem property taxes on production and certain field facilities;
- Sales and uses taxes on materials, supplies, and equipment;

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

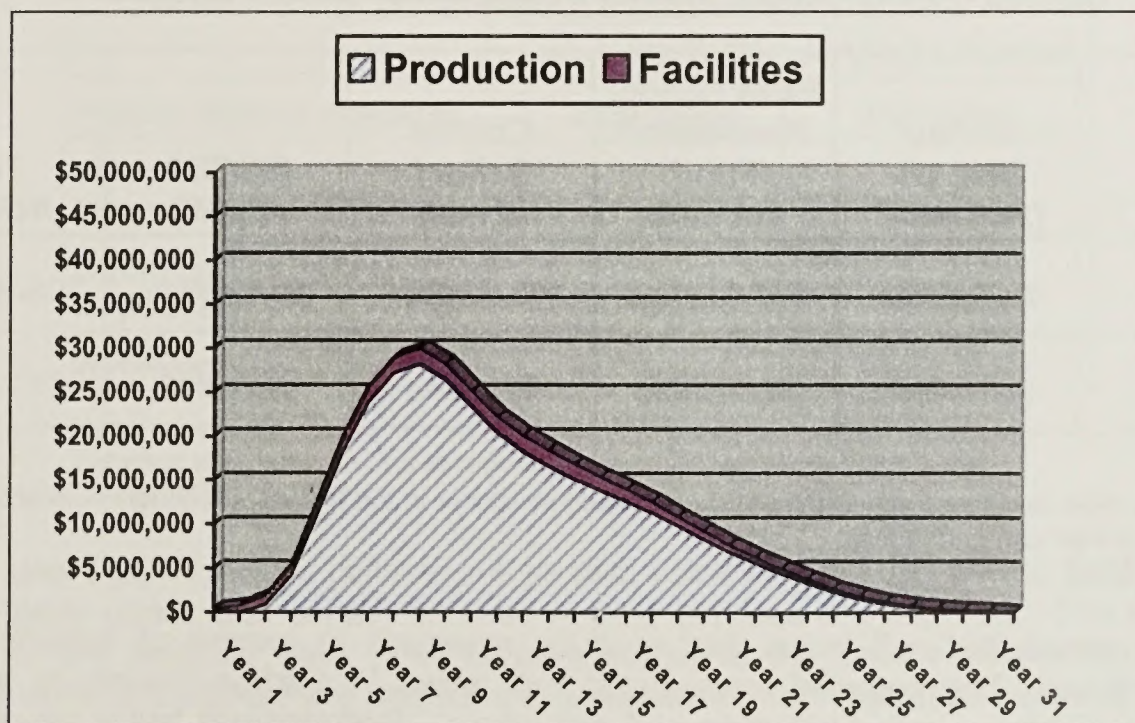
- Federal and state mineral royalty payments; and
- Wyoming state severance taxes.

Ad Valorem Property Taxes. The Proposed Action would generate ad valorem property tax to Carbon County, the Wyoming School Foundation Fund, Carbon County School District #1, and a number of special taxing districts. Direct ad valorem property taxes would be generated from two sources: (1) the value of natural gas produced and sold and (2) the value of certain well field and production facilities (underground facilities associated with wells are exempt). Indirect ad valorem tax revenues may be generated by the infrastructure investments made by gas service companies and vendors that expand facilities as a result of the incremental economic activity. Long-term employees of gas companies and vendors may purchase new properties or improve existing properties generating additional property taxes. Potential indirect revenues have not been estimated for this assessment.

Constant 2003 mill levies were used to prepare property tax estimates. The Wyoming School Foundation Program and shared county school mill levies are set by statute. Other mill levies are set each year by the county commissioners and officials of the various taxing districts within limits imposed by the state legislature; some change each year. Mill levies reflect the revenue needs of the taxing entity and estimates of assessed valuation within the entity. Natural gas is assessed based on the previous year's production. Well field facilities are depreciated after the first year of production.

Figure 4-13 displays annual Proposed-Action-related ad valorem property tax estimates based on the assumptions outlined earlier and assuming a constant total mill levy of 62.85 mills. Table 4-15 displays estimated ad valorem property tax revenues to major property taxing entities in Carbon County. Under the inputs and assumptions used for this assessment, ad valorem property tax revenues from production and facilities would total \$349 million over the 32-year life of the project or an annual average of almost \$11 million.

Figure 4-13. Proposed Action-Related Ad Valorem Property Tax Estimates.



Prepared by: BCLLC

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Carbon County and certain special districts would receive approximately \$96 million over 32 years under the assumptions used for this assessment. Note that some affected special districts only cover part of the ARPA; therefore an average of special district levies has been used for the assessment.

Table 4-15. Estimated Proposed Action-Related Ad Valorem Property Tax Revenues: Carbon County and Affected Special Districts.

	County (12 mill)	Weed & Pest (1 mill)	Recreation (1mill)	Conservation Districts (1 mill)	Avg. Total Special Districts (2.35 mill)	Total County & Special Districts
Total (32 year)	\$66.6 million	\$5.6 million	\$5.6 million	\$5.6 million	\$13 million	\$96 million
Average Annual	\$2.1 million	\$173,000	\$173,000	\$173,000	\$408,000	\$3 million

Note:

Table does not break out all special districts. Columns may not sum due to rounding.

Prepared by: BCLLC

Table 4-16 displays Proposed-Action-related revenues that would accrue to local schools and to the Wyoming School Foundation Fund. A portion of the revenue collected under the School District U-1 26.5 mill levy would accrue to the Wyoming School Foundation Fund because the district is a "recapture" district under the provisions of the School Foundation Program. Recapture means that revenues above a certain level are collected by the state for redistribution to other school districts (See chapter 3). District U-1's budget could increase as a result of student enrollment increases associated with Proposed-Action-related, longer-term population.

Table 4-16. Estimated Proposed Action-Related Ad Valorem Property Tax Revenues: Carbon County School District #1 and Other School Entities.

	School Dist. U1 (26.5 mill)*	State School Foundation Fund (12 mill)	County School (6 mill)	BOCES (1 mill)	Total Schools
Total (32 year)	\$147 million	\$66.6 million	\$33.3 million	\$5.6 million	\$252.6 million
Average Annual	\$4.6 million	\$2.1 million	\$1 million	\$173,000	\$7.9 million

Notes:

*Much of the revenue associated with District U1 levy is likely to accrue to the Wyoming School Foundation Fund. Columns may not sum due to rounding.

Prepared by: BCLLC

It should be noted that mill levies that produce revenues in excess of expenditures are frequently reduced. The potential for reduced mill levies in Carbon County is high given anticipated increases in both production and gas prices. Reduced mill levies would result in reduced taxes for property owners and other commercial and industrial interests in the county.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Federal and State Mineral Royalties and Wyoming Severance Taxes. The federal government collects a 12.5-percent royalty on the fair market value of gas produced from federal leases, less production and transportation costs. Half of the mineral royalty revenues are returned to the state where the minerals were produced. In Wyoming, a portion of the state's share is distributed to local governments and to the Wyoming School Foundation Fund. It is difficult to predict with certainty where all CBNG wells within the ARPA would be located. For this assessment, it is assumed that 64 percent of the CBNG associated with the Proposed Action would be produced from federally owned minerals, 31 percent would be produced from privately owned minerals, and 5 percent would be produced from state-owned minerals. As noted above, production associated with conventional wells has not been estimated for this assessment.

The State of Wyoming collects either a 16.67 percent or a 12.5 percent royalty on natural gas produced from state-owned minerals, depending on the circumstances of the lease. For this assessment, state mineral royalties were assumed to be 12.5 percent.

The State of Wyoming collects a 6-percent severance tax on the fair market value of natural gas produced within the state. Federal mineral royalty payments and production and transportation costs are exempt from this tax. The state distributes revenues from this fund to a variety of accounts including the General Fund, Water Development Fund, Mineral Trust Fund, and Budget Reserve. It also distributes a fixed 1 percent of the revenues to counties and municipalities.

Estimated mineral royalty and severance tax revenues are displayed in table 4-17. Actual mineral royalty and severance tax revenues would vary based on production levels, well locations, gas sales prices, and actual production and transportation costs. Actual severance tax revenues may be less than these estimates if a portion of the gas is used for production purposes.

Table 4-17. Federal Mineral Royalty and Wyoming Severance Tax Estimates.

	40-Year Total	Average Annual
Federal Mineral Royalties	\$320 million	\$10 million
Wyoming Share of Federal Mineral Royalties	\$160 million	\$5 million
Wyoming State Mineral Royalties	\$8.4 million	\$264,000
Wyoming Severance Taxes	\$271 million	\$6.8 million

Note:

Columns may not sum due to rounding.

Prepared by: BCLLC

Sales and Use Tax. Wyoming collects a 4-percent sales and use tax on the gross receipts of sales of tangible goods and certain services (drilling services are exempt). The state returns 31 percent of the revenue (less administrative costs) to the county where the taxes were collected. Counties distribute the revenues to incorporated municipalities based on population. As a local option, Carbon County also collects a 1-percent, general-purpose sales and use tax,

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

which is distributed to the county and its municipalities, and a 1-percent dedicated sales and use tax for capital facilities.

Table 4-18 displays the estimated state and local revenues that would flow from expenditures made during the drilling and field development phase of the Proposed Action, assuming that all sales and use tax payments are appropriately credited to Carbon County. Total sales and use tax revenues over the 20-year drilling cycle would be \$17.2 million dollars. Of the total, an estimated \$9.5 million would be distributed to the State of Wyoming and \$7.7 million to Carbon County and its municipalities. In addition, the Proposed Action would contribute 1 percent of taxable sales until the current local option facilities tax expires (these revenues have not been estimated).

Table 4-18. Estimated Sales and Use Tax Revenues and Distributions.

State of Wyoming						
Total	\$5.4 million					
Average Annual	\$271,000					
	Carbon County Total	County Share	Rawlins	Baggs	Dixon	All Other Towns
Total	\$4.4 million ¹	\$623,000	\$2.5 million	\$98,000	\$22,000	\$1.1 million
Average Annual	\$220,000	\$31,000	\$127,000	\$4,900	\$1,100	\$56,000

Notes:

Columns may not sum due to rounding.

¹Excludes proceeds from 1 percent local option facilities tax.

Prepared by: BCLLC

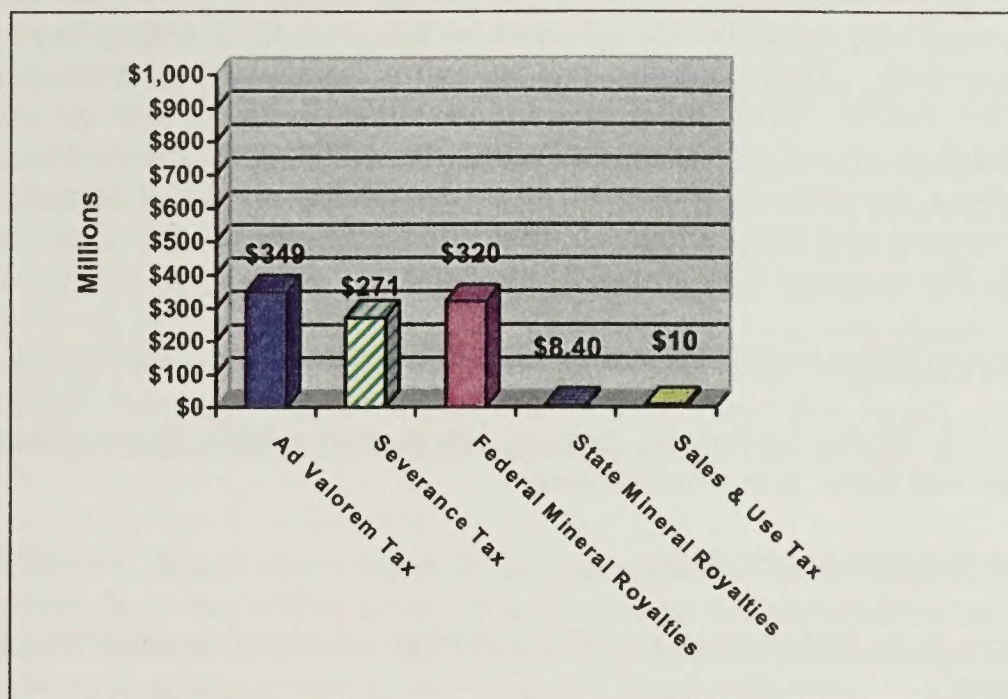
Total Revenues. Figure 4-14 summarizes the estimates of the main tax and royalty revenues attributable to the Proposed Action. The revenues are based on production, gas sales prices, tax rates, and exemption estimates, all of which are subject to change as development proceeds. In addition to these revenues, other revenues would be associated with the Proposed Action including sales and use tax payments for ongoing operations of the project and from employee and vendor spending, Oil and Gas Conservation charges, and federal income tax payments by the proponent and its employees. These revenues have not been estimated for this assessment.

Local Attitudes, Opinions, and Lifestyles

The Proposed Action has the potential to affect local attitudes, opinions, and lifestyles in two ways. Affected communities would experience change related to the increase in economic activity, employment, and population growth associated with natural gas development. The Proposed Action also has the potential to affect ranchers, who own land in the ARPA, and users of the project area, such as grazing operators, outfitters, hunters, and other recreationists.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Figure 4-14. Total Ad Valorem Property Tax, Federal Mineral Royalty, Severance Tax, and Sales and Use Tax Revenues Associated with the Proposed Action.



Prepared by: BCLLC

Carbon County has a relatively long history of oil and gas development. Consequently, residents are familiar with natural gas industry activities and their economic benefits. The combination of familiarity and anticipated economic benefit creates a climate of general community acceptance of and support for continued natural gas development in Carbon County, particularly in Rawlins and the Little Snake River Valley. Because the economy of Carbon County has generally declined since the early 1980s due to closure of several coal mines and problems in the timber industry, many residents of Carbon County and Rawlins welcome the current economic expansion resulting from natural gas development (Kilgore 2004 and Grabow 2004). Rawlins in particular has unused public and commercial infrastructure that could be redeveloped to accommodate population growth.

Within this general climate of acceptance, some residents have attitudes and values that may diminish support or create opposition for a particular development proposal. These attitudes and values include concern for use of public lands and preservation of wildlife habitat and recreation resources.

These attitudes and values are evident in a number of the comments submitted during the scoping process and comments received to the draft EIS. In addition, a discussion of these attitudes and values, as expressed by Carbon County residents, is included in the findings of the 1996 resident survey conducted for the Carbon County Land Use Plan (discussed in section 3.12).

According to the Carbon County Land Use Plan, resident response to the survey suggests "a need to balance the conservation of natural resources and the economic viability of resource-based industries in the county." Residents also showed partial support for leasing more federal lands for oil and gas development (about 50 percent countywide). These two opinions suggest that development of natural gas resources on existing leases could be generally supported by

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

residents of Carbon County, as long as they perceive that such development does not damage wildlife habitat or degrade the quality of recreation resources in the area.

The groups that would be most directly affected by the Proposed Action have mixed feelings about the development. These groups include some landowners, grazing operators, and outfitters within the ARPA. While most support resource development on public lands and believe development of natural gas resources within the ARPA is in the national interest, some are concerned about the potential effect on their operations, about changes in the relatively undeveloped landscape and about effects to their traditional way of life (Carrico 2005, Hansen 2004, Hicks 2004, Montgomery 2004 and O'Toole 2004).

Members of this group have expressed some or all of the following concerns:

- Fragmentation of the landscape, grazing lands, and wildlife habitat caused by gas field roads, well pads, and infrastructure;
- Disruption of grazing operations;
- Soil erosion from disturbance and the potential effects of erosion on streams and stock ponds;
- The potential for encroachment of weeds on disturbed land, particularly since the recent drought has weakened and killed some native plants;
- The increased potential for trespass and damage to private lands and improvements given the increased access that well field roads would provide;
- Affects on big game (many ranchers also have outfitting operations on their lands or lease lands to outfitters and hunters); and
- The potential that the operators may seek more dense well spacing in the future, further increasing the potential for each of the above identified impacts.

Other sections of this assessment analyze potential impacts to range resources, noxious and invasive species, wildlife, wildlife habitat, and a variety of measures to mitigate these impacts are either committed or proposed. Some ranchers and grazing operators are concerned that mitigation measures for these identified impacts would not be rigorously enforced or effective.

But even if mitigation measures are enforced and effective, some ranchers and grazing operators believe that the Proposed Action would change the current relatively undisturbed character of much of the rangeland/wildlife habitat within the ARPA. The effect would be to introduce or expand resource extraction, a type of low-density industrial use, which would in turn alter their traditional use and way of life.

Based on these observations, it is likely that the Proposed Action would receive general support in Carbon County communities, but individual members of specific groups with interests and concerns more directly affected by the Proposed Action could experience varying degrees of dissatisfaction with the change in use of the land.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Environmental Justice

EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (defined as those living below the poverty level).

Environmental Justice includes impacts to air, water, or other environmental values or health and safety risks that are experienced disproportionately by minority or low-income populations. As noted in section 3.12, there are no human populations located within the ARPA. There are no residences within the ARPA that are occupied year round, although some residences on ranches are temporarily or seasonally occupied. The ARPA is relatively distant from population centers, so no populations would be subjected to direct physical impacts from the Proposed Action. Therefore the Proposed Action would not directly affect the health and safety of any minority or low-income populations, nor would it directly affect their social, cultural, or economic well being.

However, the Proposed Action could result in increased incomes for low-income populations living in communities near the ARPA area. The Proposed Action would create or sustain an annual average of 578 jobs (AJEs) over the 13-year drilling and field development phase of the project, and an annual average of 161 jobs during the production phase of the project. These direct, indirect, and induced employment opportunities would occur in all sectors of the economy and provide additional job opportunities for unskilled, low-income residents, as well as those that might become skilled through local training programs. The increased labor demand would have the likely effect of reducing unemployment in the county and increasing labor force participation, two factors that could also increase incomes.

While in many cases skilled workers would be imported to the area to fill skilled and specialized labor demand, the availability of local unemployed or underemployed individuals would offer the companies the opportunity to retain workers who are already located and housed within the area. The applicant-committed measure to "Implement hiring policies that would encourage the use of local or regional workers who would not have to relocate to the area" should enhance this opportunity.

Employment of local unemployed or underemployed individuals for skilled or specialty occupations would require training and development, generally in a trade school or institution of higher education. Post high school training in Carbon County is currently offered by the Carbon County Higher Educational Center. Management, administrative, technical, and trade-related training and certification opportunities are offered including some energy-industry-specific courses and certifications. Some courses qualify for college credit and can lead to college degrees or trade certifications. The opportunity for post-high school level education for both blue collar and white collar jobs within Carbon County could provide opportunities for low-income residents to obtain and benefit from skilled and specialty employment locally.

4.12.3.2 Alternative A (No Action)

Under Alternative A, the community would not experience the effects of the Proposed Action described in section 4.12.3.1. Some local residents who may have benefited economically from the proposed development might be dissatisfied with the forgone opportunities.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.12.3.3 Alternative C

Under Alternative C it is assumed that the operators would propose to drill an equivalent number of wells each year as assumed under the Proposed Action (section 4.12.3.1). Although development protection measures could limit the number of allowable well locations within certain areas of the ARPA, the operators would have options for avoiding or mitigating impacts that could be employed to avoid some well reductions. It is anticipated that fewer wells would ultimately be drilled under Alternative C, but actual determinations would not occur until individual well sites would be proposed. Therefore the actual number of wells allowable under Alternative C has not been estimated, but would likely be less than the Proposed Action.

Economic Effects

Economic effects of Alternative C would be anticipated to be similar in kind to those associated with the Proposed Action, but reductions in economic effects would likely occur because fewer wells would be drilled as a result of development protection measures. Similarly, changes in production levels or operating costs associated with development protection measures would result in different economic effects than those associated with the Proposed Action.

Under this alternative, construction and development constraints could arise where resources exist or overlap. Where development protection measures are applied, natural gas extraction could be constrained, potentially leaving unextracted natural gas resources in the ground and causing correspondingly increased relative construction and operations costs and decreased revenues. Limited operating periods would affect the timing of development and could affect the intensity and cost of construction activities by focusing them into tighter construction windows.

Alternative-C-Related Effects on other Economic Activities within the ARPA

Under Alternative C, economic effects to ranchers, grazing operators, outfitters, hunters, and other recreation visitors would be similar to those associated with the Proposed Action except that development protection measures that reduce impacts to resources could also result in fewer adverse economic effects.

Given the substantially smaller area of disturbance associated with Alternative C, it is less likely that grazing operators whose allotments are concentrated within the ARPA would chose to forgo use of the allotment or it is possible that they would forgo use of a portion of the allotment rather than the whole allotment. Still, if these grazing operators could not find comparable grazing lands within the county at comparable costs, or if they chose to forgo grazing entirely for one or more seasons, the economic impact associated with that operator's reduction in AUMs would be forgone for the period of nonuse.

Employment and Population Effects

Employment effects of Alternative C would be similar to those associated with the Proposed Action. However, drilling and field development activities could intensify within a tighter window in response to development requirements associated with development protection measures. Drilling activities could also diminish if fewer wells were ultimately drilled under these restrictions. These effects to drilling and field development would have equivalent effects on employment. Conversely, employment effects could be reduced as compared to the Proposed Action if fewer wells were actually drilled because of development protection measures.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Population effects of Alternative C would be similar to those identified under the Proposed Action. Differences could occur related to the employment effects identified above.

Housing Effects

Housing effects of Alternative C would be similar to those identified under the Proposed Action. Differences could occur related to the employment and population effects identified above.

Effects on Community Services

Demand for community services related to Alternative C would be similar to those identified under the Proposed Action. Differences could occur related to the employment and population effects identified above.

Fiscal Effects

Fiscal effects of Alternative C would depend on the number of wells actually drilled under Alternative C. Production-related property, severance taxes, and federal mineral royalties would be reduced if fewer wells were allowed under development protection measures. Increased operations cost could also reduce federal mineral royalty, state severance tax, and county ad valorem property tax revenues on production.

Local Attitudes, Opinions, and Lifestyles

Effects on local attitudes, opinions, and lifestyles associated with Alternative C would be similar to those associated with the Proposed Action. However, ranchers, grazing operators, outfitters, hunters, and other recreation users could be less likely to experience dissatisfaction with the changes to the relatively undisturbed landscapes in certain portions of the ARPA due to a reduction in development.

Environmental Justice

Environmental justice for Alternative C would be the same as the Proposed Action.

4.12.3.4 Alternative D

Under Alternative D, it is assumed that the operators would propose to drill an equivalent number of wells each year as assumed under the Proposed Action. The actual number of wells drilled would be dependent on the operators' ability to stay within the disturbance limits associated with Alternative D while maintaining the anticipated pace of drilling and field development.

The differences in socioeconomic effects between Alternative D and the Proposed Action would therefore be related to the actual number of wells drilled as contrasted with the level of drilling assumed on figure 2-1. If the operators are unable to maintain the pace of drilling and stay within the prescribed disturbance limits, the socioeconomic effects described for the Proposed Action would be reduced proportionately to the reduction in drilling levels. Over time, however, it is likely that the same number of wells would be drilled as under the Proposed Action, but the pace of drilling would be slower and perhaps spread more evenly across the 20-year drilling and field development period to accommodate the pace of reclamation. Consequently socioeconomic effects would be reduced in the early years of the 20-year drilling schedule compared to the Proposed Action, but higher in later years, possibly resulting in a more-constant and sustained level of drilling during the 20-year period.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Economic Effects

Economic effects would be similar to those described for the Proposed Action to the extent that the operators are able to maintain the same pace of drilling. Increased drilling and well development costs would be likely as operators implement more costly measures to reduce initial disturbance and implement more intensive reclamation activities. These measures are likely to result in higher drilling and field development employment levels and correspondingly higher labor costs for the operators.

If the operators were unable to maintain the pace of drilling outlined on figure 2-1, the magnitude of economic activity, employment, and earnings would be lower on an annual basis in the early years and higher in later years, but spread more evenly across the 20-year period.

Leaseholders would experience delays in revenues as compared with the Proposed Action if actual annual drilling rates were lower under Alternative D. Otherwise, leaseholder revenues would be similar to those associated with the Proposed Action.

Alternative-D-Related Effects on other Economic Activities with the ARPA

The lesser amount of unreclaimed disturbance associated with Alternative D would be anticipated to generate fewer and less-intensive effects for both grazing operators and recreation users of the ARPA, as contrasted to the Proposed Action. This would include:

- A smaller reduction in AUMs resulting from loss of forage associated with disturbance,
- Possible lesser reductions in wildlife habitat,
- Changes in setting resulting in less displacement of hunters, and
- Fewer impacts to landowners, outfitters, and local businesses that serve hunters.

However, some impacts on grazing operators and recreation users would still be anticipated.

Employment, Population, Housing, Community Services, and Fiscal Effects

Effects on these socioeconomic aspects associated with Alternative D are dependent on the actual pace of drilling and field development. If operators maintained the drilling rates on figure 2-1, these effects would be similar to the Proposed Action. Conversely, lower annual drilling rates would cause lower effects in the early years of drilling and field development and higher effects in later years, potentially moderating the effects across the life of the project.

Under Alternative D, drilling and field development employment levels could be higher to account for differences in techniques needed to minimize disturbance and perform more-intensive reclamation activities.

Local Attitudes, Opinions and Lifestyles

Under Alternative D, rates of drilling similar to those outlined on figure 2-1 would be anticipated to result in similar effects on local attitudes, opinions, and lifestyles as described for the Proposed Action. However, lower disturbance levels would be anticipated to result in lesser impacts on grazing operators and recreation users of lands within the ARPA and possibly result in lower levels of dissatisfaction among some members of those groups.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Environmental Justice

Environmental justice effects of Alternative D would be similar to those associated with the Proposed Action. Because no environmental justice populations would be directly affected by Alternative D, no adverse environmental justice impacts are anticipated. If employment levels were lower as a result of the inability of the operators to maintain the anticipated pace of drilling and stay within disturbance limits, fewer employment opportunities would be available for low income residents of the study area. However, given the anticipated higher levels of drilling and field development anticipated for later years, employment opportunities for low-income residents could be more sustained.

4.12.4 Impacts Summary

Economic impacts of natural gas development and production would result in increased revenues and income under the Proposed Action and Alternatives C and D. Based on the assumptions used for this assessment, natural gas development would enhance regional economic conditions and generate substantial local, state, and federal tax and royalty revenues. Economic benefits would be similar in kind for the Proposed Action and Alternatives C and D. Economic and fiscal impacts would likely be reduced under Alternative C because it is likely that some development would be precluded from specific areas as a result of development protection measures, which would reduce the economic and fiscal effects of both development and production. Income to leaseholders would also likely be less under Alternative C.

As discussed above, differences between Alternative D and the Proposed Action would depend on the ability of the operators to maintain the drilling schedule outlined on figure 2-1 and stay within allowable disturbance limits. If the anticipated pace of drilling is maintained, fewer wells would be drilled in the earlier years and more drilled in later years compared to the schedule on figure 2-1. This circumstance would result in more moderate and sustained socioeconomic effects on local communities.

Natural gas-related economic benefits may be diminished slightly by reductions in grazing, hunting, and other recreation activity in the project area under all of the alternatives. Individual landowners and outfitters within the ARPA could experience economic losses associated with reductions in hunting activity. For individual land owners and outfitters, these losses could range from minimal to substantial depending on the location, development in relation to a specific property, the timing of development, actual effects on big game and big game habitat, the duration of effects, and the success of mitigation measures. Businesses in the Little Snake River Valley that provide goods and services to hunters could also experience reductions in income from reductions in hunting activity. For many of these businesses, reductions in hunting activity would be offset by increases in drilling and field development activity.

For all action alternatives, the population increment associated with drilling and field development coupled with cumulative drilling and field development activities would likely strain existing housing resources. The relatively small in-migrant population increment anticipated for communities in the Little Snake River Valley and Wamsutter could be accommodated by existing community infrastructure. Project-related sales tax, use tax, and property tax revenues would offset project-related demand for local government services in Carbon County, although revenues may lag demand in the early years of the project. Rawlins and the communities in the Little Snake River Valley would receive minimal direct tax revenues from natural gas development. Wamsutter would receive no direct revenues, except for a relatively small portion of mineral royalties and severance taxes.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Community acceptance of natural gas development would be mixed under all of the alternatives. Many residents would support the development, but some land owners, grazing operators, outfitters, hunters, and other recreational users of the ARPA are likely to experience varying degrees of dissatisfaction with the change in land use and the change in character of lands within the ARPA.

4.12.5 Additional Mitigation Measures

The economic and employment effects of all three action alternatives would be substantially increased revenues and income. The operator-committed policy of hiring local workers, to the extent that such workers are available, would enhance local economic and employment effects and reduce demand for housing and community services.

The operator-committed policy of coordinating project activities with ranching operations would minimize conflicts involving livestock movement or other ranch operations. Some aspects of the policy that would reduce conflicts and dissatisfaction among these land users include:

- Scheduling of project activities to minimize potential disturbance of large-scale livestock movements,
- Establishing effective and frequent communication with affected ranchers to monitor and correct problems, and
- Coordinating scheduling.

When coupled with cumulative demand, rig and construction camps for project workers might be necessary, as project-related demand for both temporary and longer-term housing is likely to strain or exceed existing housing resources in all area communities. Development of these camps would also free up spaces in mobile home parks in Rawlins, which could be used by longer-term workers until the local housing market is able to respond to longer-term demand.

During the interim drilling period, the BLM RFO has initiated a transportation planning process with representatives of directly affected interests including the BLM, WGFD, Carbon County, the LSRCD, and the operators. Although initially intended to address transportation issues, it has emerged as a forum for identifying and addressing existing and potential development issues and opportunities. As this process evolves and matures, it has the potential for reducing conflict and dissatisfaction with CBNG development in the ARPA.

4.13 Transportation

4.13.1 Introduction

This section identifies potential effects of the proposed project on the transportation system that would provide access to the ARPA, as well as the road network within the ARPA. This system would include federal and state highways, CCRs, BLM roads, private roads, and operator-maintained roads. Potential effects of new and improved roads within the ARPA on soils, noxious and invasive species, range resources, wildlife habitat, recreation resources, and visual resources are described in sections 4.3, 4.5, 4.6, 4.7, 4.9, and 4.10, respectively.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.13.2 Impact Significance Criteria

The Great Divide RMP (USDI-BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with transportation resources:

- To support the goals and objectives of other resource programs for managing the BLM-administered public lands and to respond to public demand access for land use authorizations.

The following criteria are used to determine whether transportation impacts would be significant and represent a balance between public access and transportation safety:

1. Substantial limitation on public access to travel with the ARPA;
2. Substantial reduction in opportunity for acquisition of access easements and road development; and
3. Increases in traffic levels on the local public transportation system that would cause the level of service on the system to fall below acceptable levels, as defined by the responsible government agency.

4.13.3 Direct and Indirect Impacts

4.13.3.1 Proposed Action

Highways and Roads Providing Access to the ARPA

Transportation effects of natural gas development and production would include increased traffic on federal and state highways and county roads providing access to the ARPA, primarily I-80, WY 789, WY 70, CCR 605N, and CCR 608 (map M-33). Depending on the outcome of the Coordinated Transportation Planning process described below, traffic could also increase on CCR 501, CCR 503, and BLM Road 3309 (map M-33).

Although access from WY 71 on the east side of the ARPA is possible from several CCRs, there are no communities in that area. Consequently, few trips would originate from areas served by those routes.

Most traffic accessing Pods 1–4 (Red Rim, Jolly Roger Alpha and Beta, and the currently dormant Pod #1) would travel on CCR 605N. Trips originating in Rawlins would access CCR 605N southwest of Rawlins. Trips originating in Rock Springs or Wamsutter would travel I-80 east to CCR 605N. Trips originating in the Little Snake River Valley are likely to travel WY 789 north and I-80 east to the CCR 605N entry point.

Traffic accessing Pods 5–9 (Doty Mountain, Sun Dog/Cow Creek, Blue Sky, Brown Cow, and Muddy Mountain) are likely to use CCR 608, which enters the ARPA east of Dad. Trips originating in both Rawlins and Rock Springs would travel I-80 west to WY 789 south to Dad. Trips originating in Wamsutter would use SCR 23/CCR 701 (the Wamsutter/Dad Road) east and trips originating in the Little Snake River Valley would use WY 70 west to WY 789 north, entering CCR 608 at Dad. Some trips originating in the Little Snake River Valley destined for the Muddy Mountain Pod may enter the ARPA from the south, using CCR 503 or CCR 501. However, the operators intend to establish primary access from CCR 608 and develop a new

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

road or improve existing roads from the north to provide access to the Muddy Mountain Pod. CCR 503, which passes through Cottonwood Canyon north of Dixon, is a narrow winding road that passes through areas with important resources values. CCR 501 is minimally improved in its upper reaches and would require substantial improvement to serve as a primary access point from the south. These factors and the fact that most ARPA traffic will originate in communities to the north would discourage heavy use of these roads for project access.

Access to the southwestern portion of the ARPA is possible using BLM 3309; however, this road is only minimally improved and crosses critical wildlife habitat. Both the BLM and the operators intend to develop policies to discourage use of this road for project access.

Table K-2 (appendix K) shows the estimated average number of trips associated with drilling, field development, and well field operations activities. Drill rigs and certain other items of heavy equipment would be transported to the ARPA and remain within the project area until their relevant work is completed. Materials and supplies would be delivered on an as-needed basis. Drilling and completion crews would commute to ARPA daily. Other contractors and vendors would commute on an intermittent, as-needed basis.

AADT estimates were developed based on a simulation of drilling activities for typical CBNG and conventional wells, construction of ancillary facilities, performance of routine operations activities and well workovers, and consideration of miscellaneous visits. Based on the results of the simulation, the Proposed Action would generate an estimated AADT of 419 (210 round trips) during the peak drilling year (Year 5). This would include an AADT of 254 for drilling and field development activities. Note that AADT is calculated on a 365-day basis and drilling and field development activities would be limited to 6 months out of each year. As such, average daily traffic would be substantially higher during the active drilling period for about 490 trips or 245 round trips per day.

During the peak drilling year, AADT for well field operations would be an estimated 165 (83 round trips) for 840 producing wells. In subsequent years, drilling and field development traffic would diminish, but operations traffic would increase as more wells come into production until 2025 when wells would begin to come off-line under the assumptions used for this assessment (See figure 4-15). Under the assumptions used for this assessment, Proposed-Action-related AADT would be in the 350 to 430 range for about 20 years. Traffic volumes could be reduced substantially by implementation of wellhead telemetry systems.

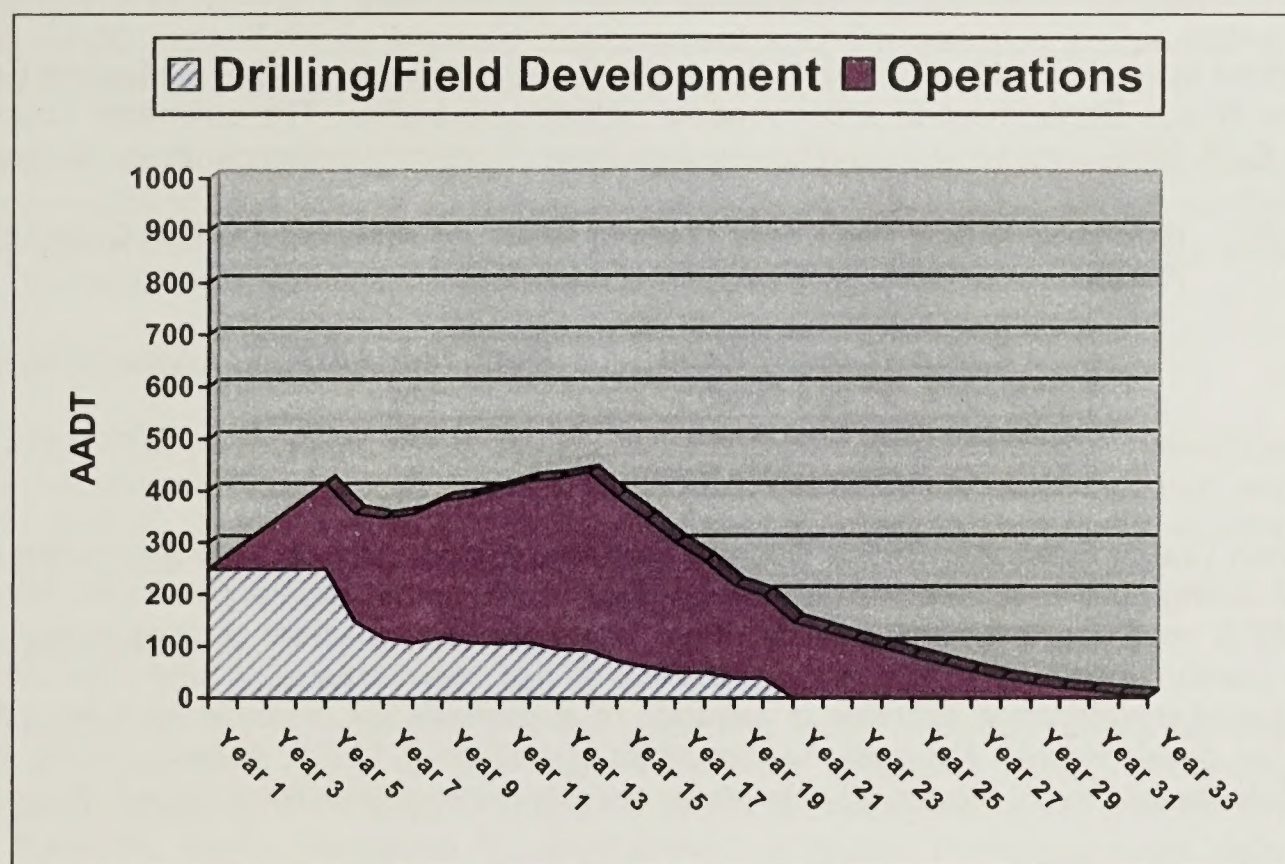
Table 4-19 contrasts peak drilling year (Year 5) AADT for federal and state highways providing access to the ARPA with 2002 and projected 2012 AADT. Proposed-Action-related peak drilling year AADT would total:

- Two percent of 2002 AADT on I-80,
- Twenty-eight percent of 2002 AADT (51 percent of truck AADT) on WY 789, and
- Nine percent of 2002 AADT (63 percent of truck AADT) on WY 70.

Proposed-Action-related traffic during the peak drilling year would make up a slightly lower percentage of projected 2012 traffic except on WY 789, where base traffic is anticipated to decrease by 2012. However, given the potential for increased drilling and field development in the area, these traffic forecasts may change.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Figure 4-15. Proposed Action AADT Estimates, Drilling/Field Development and Operations: 2005–2044.



Prepared by: BCLLC

The Proposed-Action-related increase in traffic, particularly truck traffic, would accelerate maintenance requirements on federal and state highways. Wyoming severance tax revenues and the state's share of federal mineral royalty revenues associated with the Proposed Action would offset these costs. The Proposed-Action-related increase of traffic on federal and state highways would result in a corresponding increase in the statistical probability of accidents on these highways, although actual accident rates would depend on a variety of factors.

Table 4-19. Proposed Action Peak Drilling Year (Year 5) AADT Compared with 2002 AADT and 2012 Projected AADT on Affected Highways.

Highway	2002 AADT	Projected 2012 AADT	Estimated Peak Drilling Year AADT	% 2002 AADT	% Projected 2012 AADT
I-80 (Junction WY 789)	11,760 (6,460 trucks)	15,000	213 (96 trucks)	2% (1% trucks)	1%
WY 789 (Creston Jct. - Baggs)	860 (210 trucks)	800	240 (108 trucks)	28% (51% trucks)	30%
WY 70 (Dixon west)	480 (30 trucks)	550	42 (19 trucks)	9% (63% trucks)	8%

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Table 4-20 displays estimated peak drilling year AADT on CCRs providing access to the ARPA. Although no current traffic counts are available for these roads, the estimated peak year traffic would be a substantial increase over pre-gas-development volumes.

As described in section 3.12, CCR 605N has been extensively improved by the Carbon County Road and Bridge Department to accommodate natural gas traffic. The estimated volume of traffic on CCR 605N would require a relatively high level of ongoing maintenance by the county.

Table 4-20. Proposed Action Peak Year (Year 5) AADT on Affected Carbon County Roads.

Carbon County Road	Peak Year AADT
CCR 605N (20 Mile Road)	184
CCR 608 (Wild Cow Road)	230
CCR 501 (Cherry Grove Road)	4

The Carbon County Road and Bridge Department plans to conduct extensive improvements to CCR 608 during 2005 to accommodate the high level of anticipated natural gas traffic. Although some ARPA road improvement projects have been conducted under a cooperative effort between Carbon County and the operators, the county has been required to fund improvements and increased maintenance activities in advance of substantial tax revenue flows from ARPA natural gas development. However, as described in section 4.12.3.1, Carbon County would receive substantial project-related ad valorem property taxes as production begins to flow.

Access within the ARPA

Currently, CCR 605N, CCR 608, and BLM Road 3305 serve as the transportation “spine” within the ARPA. Operator-constructed roads provide access from these roads to the pods. Based on the operators’ estimate of an average of 0.5 miles of new roads per well, an initial total of 1,000 miles of new roads would be developed over the 20-year drilling and field development period. The operators would be required to construct new roads and improve existing roads to BLM standards, except in cases where roads cross private surface. Operators would also be required to maintain new and existing roads that access natural gas facilities within the ARPA.

Effects of the Proposed Action on the transportation network within the ARPA would include improved access and new access to portions of the ARPA for landowners, grazing operators, and recreation users. Potential effects would include impacts to important resource values. Portions of the ARPA are located in areas that contain sensitive resources. Construction of new roads or improvement of existing roads in these areas have the potential to impact those sensitive resources. However, certain mitigation measures would reduce these impacts: successful implementation of BLM road standards, RMP stipulations, operator-proposed mitigation measures, the preconstruction planning and site layout process, and the coordinated transportation planning process described in section 4.13.5.

The traffic associated with Proposed-Action-related drilling, field development, and operations would require substantial improvements on Carbon County and BLM roads used for access within the ARPA and would also accelerate maintenance requirements on existing, upgraded, and new roads. Exacerbating road maintenance factors include the unavoidable use of roads during wet and muddy conditions to maintain gas field facilities and excessive speed.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Carbon County would have substantial costs associated with improving and maintaining county roads for natural gas development and operations. The substantial revenues that would accrue to the county from natural gas production would offset these costs. However, Carbon County has and would expend funds for road improvement and maintenance in the ARPA before receiving substantial project-related revenues.

The increased traffic in the ARPA, particularly during the drilling and field development phase, would correspondingly increase the potential for vehicle/livestock accidents, conflicts with livestock operations, damage to range improvements (gates, cattle guards, etc.) during that period. These potential impacts are discussed in section 4.6.

4.13.3.2 Alternative A (No Action)

Under Alternative A, transportation effects would be limited to impacts associated with previously approved oil and gas development. No additional roads would be created, and traffic would be limited to trips necessary to develop and maintain production of existing wells associated with the Atlantic Rim pods.

4.13.3.3 Alternative C

Under Alternative C, it is assumed that the operators would propose to drill an equivalent number of wells each year as assumed under the Proposed Action. Consequently, transportation effects of Alternative C would be similar to those associated with the Proposed Action. However, under Alternative C, development protection measures could reduce the number of roads in portions of the ARPA with high environmental values as a result of rerouting roads to avoid such areas. Where development protection measures require rerouting of roads, limitations on disturbance, or other actions, additional road development costs and increased road construction times could occur. Specific effects from implementation of these measures would be identified in the anticipated ROD for the project during subsequent site-specific NEPA analyses.

To the extent that development protection measures resulted in a lesser number of wells being drilled in the ARPA, drilling, field development, and production-related traffic volumes would be correspondingly lower than those associated with the Proposed Action.

4.13.3.4 Alternative D

Under Alternative D, it is assumed that the operators would propose to drill an equivalent number of wells each year as assumed under the Proposed Action. Consequently, transportation effects of Alternative D would be similar to those associated with the Proposed Action. To the extent that the operators were unable to maintain the anticipated pace of development and remain within disturbance limits, the pace of development of resource roads would be correspondingly diminished and traffic volumes would also be correspondingly reduced. This could have the effect of extending length of time for both drilling, field development, and production. Under these circumstances, peak annual traffic volumes would be reduced, but the period during which both drilling- and production-related traffic would occur within the ARPA would be extended.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.13.4 Impact Summary

Transportation effects of natural gas development and production associated with the Proposed Action and other action alternatives would include increased traffic on federal and state highways and county roads providing access to the ARPA. There would also be a statistical increase in the potential for accidents on these roads.

Transportation effects within the ARPA would occur on Carbon County, BLM, private, and operator-maintained roads. Operators would be required to construct new roads and improve existing roads to BLM standards, except in cases where roads cross private surface. Operators would also be required to maintain new and existing roads accessing natural gas facilities within the ARPA. All action alternatives would increase and improve access within the ARPA for ranchers, grazing operators, and recreation users. Conversely, development of new roads and improvement of existing roads result in higher road maintenance costs for Carbon County, offset by project-related revenues to the county.

4.13.5 Additional Mitigation Measures

In addition to the operator-committed measures, a coordinated transportation plan would be developed for the ARPA. A transportation plan would minimize construction of new roads, foster proper sizing of roads, and assign road maintenance responsibilities. The coordinated transportation process would include the BLM, the operators, Carbon County, WYDOT, the LSRCD, WGFD, private landowners, livestock operators, and other affected parties. The initial transportation planning effort would identify the most efficient and resource-sensitive locations for collector and local roads (existing roads would be used as collectors and local roads whenever possible to minimize the amount of surface disturbance within the area). In addition to development of new roads, the transportation plan would consider administrative closure and seasonal closure of existing roads, and the restriction of wellfield traffic on certain existing roads. The transportation planning process would also consider erosion prevention and minimization, prevention, and eradication of noxious and invasive species.

Transportation planning would continue to occur on an annual basis to:

- Assess ongoing effects on resource values;
- Identify the minimum road network necessary to support annual drilling and field development activities;
- Review and assign construction and maintenance responsibilities;
- Identify roads appropriate for abandonment and reclamation; and
- Identify fences, gates, and cattle guards which should be upgraded to accommodate heavy trucks and equipment.

Operator responsibilities for preventive and corrective maintenance of roads in the ARPA would extend throughout the duration of the project and include blading; cleaning ditches and drainage facilities; dust abatement; control of noxious and invasive species; maintenance of fences, gates, and cattle guards; and other requirements as directed by the BLM and private landowners.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.14 Health and Safety

4.14.1 Introduction

Potential health and safety impacts associated with the action alternatives are similar to those associated with existing conditions in the ARPA. However, the risk of certain types of impacts would increase as the amount of natural gas development increases. Potential health and safety impacts include occupational hazards associated with oil and gas exploration and development, risk associated with vehicular travel on improved and unimproved roads, and range fires.

4.14.2 Impact Significance Criteria

No specific health and safety standards were identified in the Great Divide RMP. In general, health and safety effects of the action alternatives would be considered significant if they resulted in substantially increased risk to the public.

4.14.3 Direct and Indirect Impacts

4.14.3.1 Proposed Action

Potential health and safety effects associated with the Proposed Action include hazards associated with natural gas development and operations; risk associated with vehicular travel on county, BLM, and operator-maintained roads; firearms accidents during hunting season and by casual firearms use, such as plinking and target shooting; and natural events, such as range fires.

Health and safety impacts of the Proposed Action would include a relatively low risk to project workers from industrial accidents, firearm accidents, and natural disasters. There would be a slight increase in risk of traffic accidents and range fires for the general public during drilling and field development; that increased risk would be reduced but not eliminated during field operations.

Occupational Hazards

The BLM, Occupational Safety and Health Administration (OSHA), USDOT, and Wyoming Oil and Gas Conservation Commission each regulate certain safety aspects of oil and gas development. The primary federal regulations related to health and safety requirements for oil and gas operations are specified under 43 CFR Ch. II, subpart 3162.5. These regulations require prior approval of a drilling and operations plan by the BLM. The plan addresses the procedures to be employed for protection of environmental quality including safety precautions, control and removal of waste, spill prevention, fire prevention, and fire fighting procedures. Adherence to relevant safety regulations on the part of the operators and enforcement by the respective agencies would reduce the probability of accidents. In addition, given the remote nature of the project area, and the relatively low use of these lands by others, occupational hazards associated with the Proposed Action would mainly be limited to employees and contractors rather than the public at large.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Pipeline Hazards

Increasing the miles of gathering and transmission pipelines within the ARPA would increase the chance of a pipeline failure. However, pipeline hazards would result in minimal risk to public health and safety due to the low probability of failure, the remoteness of the project area, and the low level of anticipated non-project-related construction and excavation. Compliance with signing requirements for pipeline ROWs would reduce the likelihood of pipeline ruptures caused by excavation equipment, particularly in the vicinity of road crossings or areas likely to be disturbed by road maintenance activities.

Hazardous Materials

Drilling, field development, and production activities require use of a variety of chemicals and other materials, some of which would be classified as hazardous. A Hazardous Materials Management Plan is provided as appendix C. This plan was developed pursuant to BLM Instruction Memoranda Numbers WO-93-344 and WY-94-059, which require that all NEPA documents list and describe any hazardous or extremely hazardous materials that would be produced, used, stored, transported, or disposed of as a result of a proposed project.

Potential impacts associated with hazardous materials include human contact; inhalation or ingestion; and the effects of exposure, spills, or accidental fires on soils, surface water, groundwater resources, and wildlife.

The risk of human contact would be limited predominately to ARPA operator and contractor employees. A Hazard Communication Program, SPCC Plans, and other mitigation measures described in appendix H would reduce the risk of human contact, spills and accidental fires, and provide protocols and employee training to deal with these events should they occur.

Other Risks and Hazards

Highway and road safety impacts are discussed in section 4.13. Sanitation and hazardous material impacts would be avoided or reduced by the implementation of the mitigation measures outlined in appendix H.

The potential for firearms-related accidents would occur primarily during hunting season. The increased activity in the ARPA during drilling and field development would likely discourage hunting in the immediate vicinity of the activity during that period. Consequently the risk of firearms-related accidents should be minimal. During project operations, the relatively few personnel on site would also result in minimal risk of firearms-related accidents.

The risk of fire in the project area would increase under the Proposed Action. This risk would be associated with construction activities; industrial development; and the presence of fuels, storage tanks, natural gas pipelines, and gas production equipment. However, this risk would be reduced by the placement of facilities on pads and locations that are graded and devoid of vegetation. In the event of a fire, property damage most likely would be limited to construction- or production-related equipment and range resources. Fire suppression equipment, a no smoking policy, shutdown devices, and other safety measures typically incorporated into gas drilling and production activities would help to minimize the risk of fire. There would be a heightened risk of wildfire where construction activities place welding and other equipment in close proximity to native vegetation. Given the limited public use and presence in the project

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

area, the risk to the public would be minimal. There would be a small increase in risk to area fire suppression personnel associated with the Proposed Action.

There would be an increased potential for weather-related hazards associated with the Proposed Action. Many development locations in the ARPA are remote and rapidly moving storms can impair or preclude vehicular travel in a fairly short time. It is possible that workers may get stranded in remote locations requiring rescue operations by emergency management personnel. Proper training of development and operations workers, coordination with emergency management agencies, and frequent mapping of development locations can reduce the potential for weather-related impacts.

Based on the foregoing assessment, risks to public health and safety should not substantially increase as a result of the Proposed Action.

4.14.3.2 Alternative A (No Action)

Under this alternative, no incremental oil- and gas-related development would occur, so no additional effects to health and safety would occur for this alternative.

4.14.3.3 Alternative C

Under Alternative C, it is assumed that the operators would propose to drill an equivalent number of wells each year as assumed under the Proposed Action. Consequently, Alternative C health and safety effects would be the same as those associated with the Proposed Action. To the extent that fewer wells were drilled as a result of Alternative C, the probability of accidents would be lower than that associated with the Proposed Action.

4.14.3.4 Alternative D

Under Alternative D, it is similarly assumed that the operators would propose to drill an equivalent number of wells each year as assumed under the Proposed Action. Consequently, Alternative D health and safety effects would be the same as those associated with the Proposed Action. To the extent that the operators were unable to maintain the anticipated pace of development and remain within disturbance limits, the probability of accidents would be reduced proportionately to reductions in drilling and field development.

4.14.4 Additional Mitigation Measures

The operators should coordinate emergency response planning with the Carbon County Emergency Management Agency. They should also provide documentation regarding compliance with Federal Hazardous Material Regulations and the Uniform Fire Code. These mitigation measures, coupled with the measures outlined in appendix H, would be sufficient to mitigate risks to public health and safety.

4.15 Noise

4.15.1 Introduction

Noise associated with the action alternatives would be caused by machinery used during drilling, construction of pipelines and access roads, construction and operation of ancillary

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

facilities, drilling and production traffic including heavy trucks and related equipment, and compressor stations.

4.15.2 Impact Significance Criteria

The following criterion was used to assess the significance of noise impacts related to this project:

- Long-term activities that would exceed federal 55 dBA maximum standards for noise at either human- or animal-sensitive locations.

4.15.3 Direct and Indirect Impacts

4.15.3.1 Proposed Action

At specific locations within the ARPA, noise levels associated with drilling, field development, and operations activities may temporarily exceed the EPA threshold: average 24-hour noise level of 55 dBA. However, few persons other than employees would be affected by noise within the ARPA due to a lack of year-round-occupied human residences and the low level of human occupation within the project area.

Implementation of the Proposed Action has the potential to create noise-generated impacts that emanate from machinery used during drilling; construction of drill sites, pipelines, access roads, and ancillary facilities; and from the operation of heavy trucks and related equipment. During field operations, noise would be generated by compression facilities, pumper trucks, road maintenance equipment, and well workover operations.

Noise associated with natural gas drilling, field development, and field operations can affect human comfort and safety (at extreme levels). Noise impacts can also modify animal behavior (See section 4.7). The magnitude of noise impacts are contingent on a number of factors including the intensity and pitch of the source, air density, humidity, wind direction, screening/focusing by topography or vegetation, and distance to the observer. A variety of heavy equipment and machinery commonly used during drilling, field development, and production operations generate noise levels in excess of the 55 dBA maximum standard. Noise impacts created by these activities are short term, lasting as long as drilling, construction, or field maintenance activities are performed. Under typical conditions, noise levels decline below the 55 dBA maximum standard at a relatively short distance (less than 1 mile from the source) depending on the factors outlined above.

Drilling, field development, and field operations workers would be the only groups directly affected by Proposed-Action-related noise disturbances for more than a brief period of time. These groups are subject to OSHA regulations regarding industrial noise protection. Grazing operators and recreation users of the area would typically be affected by noise impacts only for the brief period required to pass by project sites.

Natural gas compression facilities would be a source of long-term noise impacts. These impacts would exceed the 55 dBA maximum standard at the compression site, but noise levels would be attenuated to below acceptable levels a mile or less away. There are no year-round occupied residences located within the ARPA and residences occupied occasionally (during livestock operations) are located on private land. Locations of compressor stations on private

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

land would be determined in negotiations for surface use agreements. Therefore, field operations workers are likely to be the only group affected by compressor noise for other than brief periods of time.

Based on the foregoing and the noise mitigation measures contained in appendix E, noise impacts to the public associated with the Proposed Action would be minimal and short-term in nature.

4.15.3.2 Alternative A (No Action)

Under this alternative, there would be no incremental noise-related effects.

4.15.3.3 Alternative C

Under Alternative C, it is assumed that the operators would propose to drill an equivalent number of wells each year as under the Proposed Action. Consequently, Alternative C noise effects would be the same as the Proposed Action. To the extent that fewer wells were drilled as a result of Alternative C, there would be correspondingly fewer locations where noise disturbances would occur.

4.15.3.4 Alternative D

Under Alternative D, it is similarly assumed that the operators would propose to drill an equivalent number of wells each year as under the Proposed Action. Consequently, Alternative D noise effects would be the same as those associated with the Proposed Action. To the extent that the operators were unable to maintain the anticipated pace of development and remain within disturbance limits, the number of sites with noise disturbances would be reduced proportionately to reductions in drilling and field development. Under these circumstances, the period during both drilling- and production-related noise disturbances would likely be extended.

4.15.4 Additional Mitigation

In addition to the measures described in appendix E, measures to mitigate noise impacts would include the following:

In any area of operations where noise levels may exceed federal OSHA safe limits, the operators and their contractors would provide and require the use of proper personnel protective equipment by employees.

4.16 Wild Horses

Because SMAs are areas within the ARPA, impacts to these areas have been evaluated by resource in this chapter. This section, therefore, is organized by SMAs instead of the six topics included under previous sections (e.g., impacts summary, additional mitigation measures).

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.17 Special Management Areas

4.17.1 Introduction

Currently, there are two existing special management areas that are partially within the ARPA. These areas are the Sand Hills ACEC and Red Rim Daley Cooperative Wildlife Habitat Management Area. The proposed JO Ranch expansion would become part of the Sand Hills ACEC through the addition of lands acquired from a land exchange. In addition, two special management areas have been proposed for the RFO draft RMP and include the Upper Muddy Creek Watershed/Grizzly area and the Cow Butte/Wild Cow area. Portions of the aforementioned proposed special management areas would also occur within the ARPA.

In general, special management areas that occur within the ARPA were delineated for the protection of fish and wildlife species and their habitat. Therefore, the impact significance criteria would be the same as that found in the wildlife section (4.7.2, Impact Significance Criteria). In addition, impact significance criteria for the proposed Sand Hills/JO Ranch expansion area can be found in cultural section (4.11.2, Impact Significance Criteria).

BMPs will be applied under all alternatives as COAs where proposals conflict with identified resources (appendix H).

4.17.2 Direct and Indirect Impacts (Common to All)

4.17.2.1 Proposed Action

As described in detail in chapter 2, a total of 1,800 new CBNG wells and 200 conventional wells would be drilled and developed under this alternative during the next twenty years with an expected LOP of 30–50 years. Well placement within the ARPA is not known at this time, however, development would occur across the analysis area and within and near existing pods that were developed under the Interim Drilling Policy (appendix A).

On average, there would be 63 acres of pre- and 25 acres of post-reclamation disturbance with a maximum of eight well pads per section.

4.17.2.2 Alternative A (No Action)

Under the No Action Alternative, the Proposed Action would not be approved.

4.17.2.3 Alternative C

Under Alternative C, as under the Proposed Action, a total of 2,000 new CBNG wells would be drilled and developed under this alternative during the next twenty years with an expected life of project (LOP) of 30–50 years. However, development would potentially be constrained in areas that have critical resource concerns, such as fisheries, hydrology, soils and wildlife.

4.17.2.4 Alternative D

This alternative emphasizes reclamation and monitors successful reclamation within SMA's or Category A areas. These areas include management areas with sensitive fish populations, big game crucial winter range habitats, including ACECs, Wildlife Habitat Management areas, and

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

silver sage/antelope bitterbrush communities. Category A is about 72,200 acres in extent. A limitation is also placed on Category A areas to limit the disturbance to an average of less than 6.5 acres or less per well site location. Category A areas would be managed more intensively and emphasize successful reclamation. However, there is potential for all or a large portion of the disturbance for Category A areas to occur within a single SMA.

Annual planning would require the operators to submit to the BLM a proposed plan of operation for the forthcoming year. The BLM will then work with the operators at the site-specific level to minimize surface disturbance by applying appropriate lease stipulations, BMPs, COAs, and other measures deemed necessary to minimize impacts to this SMA.

4.17.3 Cow Butte/Wild Cow Area

The proposed Cow Butte/Wild Cow area consists of 63,697 acres and is managed to protect crucial winter range for big game and to maintain or enhance the aspen and mountain shrub complexes found within the area. A total of 40,414 acres (63 percent) of the proposed Cow Butte/Wild Cow area occurs with the ARPA.

4.17.3.1 Direct and Indirect Impacts

Direct and indirect impacts to the proposed Cow Butte/Wild Cow Creek area common to all alternatives would be similar to those found in impacts common to all alternatives in the wildlife section (4.7.3.1). Of special concern within this SMA are the steep slopes and gullies which have the potential to accelerate erosion that would lead to increased habitat degradation. Steep slopes would require additional surface disturbance to meet road standards, resulting in increased habitat loss. Impediments to wildlife movement from existing fences and habitat fragmentation would be compounded by increased surface disturbing activities associated with development.

The loss or reduction of usable elk crucial winter range is also a concern in the Cow Butte/Wild Cow Creek area. Impacts would result from restrictions of movement that would occur from high snow pack to the east at higher elevations and project development to the west at lower elevations. Therefore, there would be a reduction in available crucial winter range habitat for elk. This would further confine animals to the remaining crucial winter range habitat between the development areas and high snow pack areas. This would result in increased browse use of the remaining crucial winter range habitat and increase animal stress.

4.17.3.2 Proposed Action

Impacts to the Cow Butte/Wild Cow area from resource development would be similar to those described in section 4.7, Wildlife and section 4.8, Special Status Plants, Wildlife and Fish Species.

4.17.3.3 Alternative A (No Action)

Please refer to section 4.17.2.2.

4.17.3.4 Alternative C

Some of the development protection measures included in Alternative C would reduce road densities, minimize well pad size, and improve reclamation. This would occur through

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

site-specific review and mitigation to meet the requirements of the SMA. Existing levels of public access would be maintained through the use of remote monitoring and gating of new roads. The avoidance of important wildlife vegetation communities would be required, such as, aspen, juniper woodland, true mountain mahogany, and serviceberry communities. To avoid fragmentation of movement corridors, fences would be converted to BLM standards in coordination with grazing permittees. Detailed descriptions of resource concerns and protective measures can be found in appendix L.

4.17.3.5 Alternative D

Please refer to section 4.17.2.4.

4.17.4 Upper Muddy Creek Watershed/Grizzly Area

The Upper Muddy Creek Watershed/Grizzly area consists of 111,110 acres and is managed for protection of native Colorado fish fauna unique to the Muddy Creek watershed and big game crucial winter range (See section 4.7, wildlife and section 4.8, Special Status Plants, Wildlife, and Fish Species). A total of 20,966 acres (19 percent) of the Upper Muddy Creek Watershed/Grizzly area occurs within the ARPA of which 10,610 acres private, 9,748 acres BLM, and 638 acres State. However, sampling by BLM biologists and University of Wyoming researchers have identified the highest proportion of BLM sensitive native species within this portion of the ARPA (Bower 2005).

4.17.4.1 Direct and Indirect Impacts

Direct and indirect impacts to the proposed Upper Muddy Creek Watershed/Grizzly area common to all alternatives would be similar to those found in impacts common to all alternatives in the Wildlife section, 4.7.3.1, and Special Status Plants, Wildlife, and Fish Species section, 4.8.3.1.

4.17.4.2 Proposed Action

Impacts to the Upper Muddy Creek Watershed/Grizzly area from resource development would be similar to those described in section 4.7, Wildlife and section 4.8, Special Status Plants, Wildlife, and Fish Species.

4.17.4.3 Alternative A (No Action)

Please refer to section 4.17.2.2.

4.17.4.4 Alternative C

Some of the development protection measures included in Alternative C would reduce road densities, minimize well pad size, and improve reclamation through detailed development, transportation, and reclamation plans. In addition, no new road crossings of Muddy Creek would be allowed and existing levels of public access would be maintained through the use of remote monitoring and gating of new roads. Non-chlorine deicing and dust control agents would be used to minimize toxic effects to plants, fish, and other aquatic organisms. The avoidance of important wildlife vegetation communities would be required, such as, aspen, juniper woodland, true mountain mahogany, and serviceberry communities. To avoid fragmentation of movement corridors, fences would be converted to BLM standards in coordination with grazing permittees.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

Detailed descriptions of resource concerns and protective measures for the Upper Muddy Creek Watershed/Grizzly area can be found in appendix L.

4.17.4.5 Alternative D

Please refer to section 4.17.2.4.

4.17.5 Sand Hills ACEC and Proposed JO Ranch Expansion

The Sand Hills ACEC consists of 12, 669 acres. This includes the JO Ranch Expansion which is currently proposed under the RFO draft RMP, and is managed for the protection of the unique vegetation community complex, to maintain wildlife habitat values, minimize soil erosion, and promote recreational opportunities. A total of 5,024 acres (39.7 percent) of the Sand Hills ACEC occurs within the ARPA.

4.17.5.1 Direct and Indirect Impacts

Direct and indirect impacts to the proposed Sand Hills ACEC and Proposed JO Ranch Expansion area common to all alternatives would be similar to those found in impacts common to all alternatives in the wildlife section, 4.7.3.1.

4.17.5.2 Proposed Action

Impacts to the Sand Hills ACEC and proposed JO Ranch expansion would be similar to those described in the direct and indirect impacts, common to all section, 4.17.2.1.

4.17.5.3 Alternative A (No Action)

Please refer to section 4.17.2.2.

4.17.5.4 Alternative C

Some of the development protection measures included in Alternative C would reduce road densities, minimize well pad size, and improve reclamation through detailed development, transportation, and reclamation plans. Existing levels of public access would be maintained through the use of remote monitoring, gating, and seasonal closures of new roads. Non-chlorine deicing and dust control agents would be used to minimize toxic effects to plants, fish, and other aquatic organisms. Surface disturbance within important wildlife vegetation communities such as silver sagebrush and antelope bitterbrush would be limited to protect important seasonal and crucial winter range habitats. To avoid fragmentation of movement corridors, fences would be converted to facilitate big game movement in coordination with grazing permittees. Detailed descriptions of resource concerns and protective measures for the Sand Hills SMA can be found in appendix L.

4.17.5.5 Alternative D

Please refer to section 4.17.2.4.

Chapter 4. ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.17.6 Red Rim/Daley Area

The Red Rim/Daley area consists of 25,962 acres and is managed for the protection of crucial winter range habitat for pronghorn antelope and nesting habitat for raptors. A total of 3,190 acres (19 percent) of the Red Rim/Daley area occurs within the ARPA.

4.17.6.1 Direct and Indirect Impacts

Direct and indirect impacts to the proposed Red Rim/Daley area common to all alternatives would be similar to those found in impacts common to all alternatives in the Wildlife section, 4.7.3.1.

4.17.6.2 Proposed Action

Impacts to the Red Rim/Daley area would be similar to those described in the Direct and Indirect Impacts (common to all, section 4.17.2.1).

4.17.6.3 Alternative A (No Action)

Please refer to section 4.17.2.2.

4.17.6.4 Alternative C

Some of the development protection measures included in Alternative C would reduce road densities, minimize well pad size, and improve reclamation. This would occur through site-specific review and mitigation to meet the requirements of the SMA. Existing levels of public access would be maintained through the use of remote monitoring and gating of new roads. To avoid fragmentation of movement corridors and crucial winter range, fences would be converted to BLM standards in coordination with grazing permittees. In addition to standard raptor wildlife stipulations, actions would be taken to minimize impacts to important nesting substrate. Detailed descriptions of resource concerns and protective measures can be found in appendix L.

4.17.6.5 Alternative D

Please refer to section 4.17.2.4.

Chapter 5

Cumulative Impacts Analysis

5 Cumulative Impacts Analysis

NEPA requires an assessment of potential cumulative impacts. Federal regulations (40 CFR 1500–1508) define cumulative impacts as:

...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Potential cumulative impacts are assessed at the resource level. The area of the cumulative impact analysis (CIA) area for past, existing, and RFFAs that may generate cumulative impacts varies depending on the resource under consideration. For example, the CIA area for air quality effects is regional in nature; therefore, the scope of activities considered is necessarily broad. In contrast, the CIA area for geology and minerals considers the project area associated with the proposed action and alternatives; therefore, the scope of potential cumulative activities considered is much narrower.

This discussion of potential cumulative impacts assumes the successful implementation of the environmental protection and mitigation measures discussed in the various appendices and chapter 4 of this EIS, as well as compliance with the Great Divide RMP and all applicable federal, state, and local regulations and permit requirements. The analysis of cumulative impacts addresses both potential negative and positive impacts.

5.1 Past, Existing, and Reasonably Foreseeable Future Activity

Past, existing, and RFFAs are organized by CIA area and include the following:

- ARPA,
- Southeastern Sweetwater County/southwestern Carbon County CIA area,
- Watershed CIA area, and
- Regional CIA area.

5.1.1 Atlantic Rim Project Area

Historic and existing activities in the ARPA include livestock grazing; dispersed recreation; and oil and gas exploration, development, and production. RFFAs within the ARPA are the action alternatives and the no action alternative.

While additional natural gas proposals are possible, this analysis incorporates all reasonably foreseeable natural gas development activity within the project area based on current knowledge of the area's geology and natural gas drilling and development technology. Other potential developments are also possible, such as coal mining, wind power development, and hydropower. Such activities have not been proposed and therefore are not reasonably foreseeable. If these factors change and additional proposals are submitted, assessment under NEPA would likely be required.

Existing disturbance from oil and gas development within the ARPA is approximately 600 acres, for a total existing disturbance of around 0.22 percent of the 270,080 acres comprising the

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

project area. During the construction phase, the Proposed Action alternative would disturb up to 15,800 acres. Under Alternative A (No-Action), no additional surface disturbance would occur. Alternative C could shift some disturbance on federal minerals from higher sensitivity areas to lower sensitivity areas through the use of protection measures, with maximum disturbance of 13,286 acres. Alternative D would cap unreclaimed disturbance at 7,600 acres or 2.8 percent of ARPA. Disturbance areas within the ARPA would be reduced upon reclamation of pipeline ROWs and unused portions of drill pad and ancillary facility disturbances during the production phase for each alternative. Under the Proposed Action and Alternative C reclamation would reduce impacts to 6,200 acres for a cumulative impact of 6,800 acres or 2.5 percent of the ARPA. Reclamation would reduce impacts to 5,000 acres under Alternative D. There would be no impacts to reduce under Alternative A (No Action).

5.1.2 Southeastern Sweetwater County/Southwestern Carbon County CIA Area

Past and historic activities occurring in the area surrounding the proposed project include oil and gas exploration, development, and production; dispersed recreation; ranching and grazing; and residential, commercial, and industrial development in the communities of Rawlins, Wamsutter, and Baggs.

RFFAs in adjacent areas primarily involve natural gas development (map M-5). The Proposed Action is located in a region of extensive natural gas development. The projects and the NEPA documents from which potential cumulative impacts were obtained are listed below.

- **The Desolation Flats Natural Gas Field Development Project Environmental Impact Statement (USDI-BLM 2004a)** provided analysis associated with a maximum development of 385 natural gas wells at 361 locations, along with associated access roads, pipelines, and other ancillary facilities. The Desolation Flats Project Area encompasses 233,542 acres, located about 20 miles west of the ARPA. The Desolation Flats project area included two other EIS project areas with RODs in effect, namely Mulligan Draw and Dripping Rock. These two areas were included in the Desolation Flats project area EIS to analyze the potential for increased well density.
- **The Greater Wamsutter Area II Natural Gas Development Project Environmental Impact Statement (USDI-BLM 1995)** provided an analysis of impacts associated with a maximum development pattern of 750 new production wells at 300 locations within this area and associated access roads, pipelines, and other ancillary facilities. This analysis area is located to the northwest of the ARPA and includes approximately 334,191 acres.

Development within this area reached the levels analyzed in the EIS for that project (300 well locations). Directional drilling proved to be technically impractical or uneconomical in many areas within the Greater Wamsutter II project area, and additional well locations beyond those analyzed in the EIS were required to develop the anticipated 750 production wells. The expansion of development in this project area and development in the Continental Divide area were combined in one analysis to make NEPA compliance more efficient and to facilitate the analysis of cumulative impacts.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

- **The Continental Divide/Wamsutter II Natural Gas Development Environmental Impact Statement and ROD (USDI-BLM 2000a)** includes the Continental Divide area combined with the Greater Wamsutter II project area. The combined project area is generally located in Townships 15 through 23 North, Ranges 91 through 99 West, in Sweetwater and Carbon Counties, Wyoming. The total combined area encompasses approximately 1,061,200 acres. This project is located west of the ARPA.

The EIS for this combined area provides an assessment of environmental impacts associated with development of 3,000 natural gas wells. Based on that assessment, the BLM approved development of up to 2,130 wells in 1999, 50 percent of which are on federal lands within the project area. The project is to continue for approximately 20 years with a project life of 30 to 50 years. Various associated facilities (e.g., roads, pipelines, power lines, water wells, disposal wells, evaporation ponds, and compressor stations) would also be constructed.

- **Creston/Blue Gap Natural Gas Project Environmental Impact Statement (USDI-BLM 1994)** was approved on October 4, 1994, and provides an assessment of the environmental consequences of a proposed natural gas development project located immediately west of the ARPA. The BLM's decision allowed a maximum of 275 wells on 250 locations on a 160-acre spacing pattern. This natural gas development overlaps slightly on the ARPA's western edge.
- **The Hay Reservoir Unit Natural Gas Infill Development Environmental Assessment (USDI-BLM 2004d)** involved a natural gas production area located northwest of the ARPA and the Greater Wamsutter II project area. It analyzed impacts of an increase of up to 25 additional wells over 3 years over the existing 44 wells.
- **The South Baggs Area Natural Gas Development Project EIS (USDI-BLM 2000b)** analyzed potential impacts of drilling 50 additional natural gas wells in the South Baggs area which is located south of the ARPA.
- **The Vermillion Basin Natural Gas Exploration and Development Project Environmental Assessment (USDI-BLM 2002f)** analyzed potential impacts of drilling up to 56 wells in the 92,490-acre Vermillion Basin Project Area, located approximately 55 miles southwest of the ARPA.

5.1.3 Watershed CIA Area

Cumulative analysis of natural resources that relate to watershed function and stability should occur at the watershed level. Thus, the CIA area for soils, water resources, vegetation, and wetlands includes two components: (1) an analysis of potential cumulative impacts within the ARPA and (2) an analysis of potential cumulative impacts within watersheds that contain the ARPA.

The watershed area (map M-14) considered in the CIA was based on the USGS-delineated watershed boundaries that are contained in or are adjacent to the ARPA. The ARPA falls predominantly within the Little Snake River drainage basin and the Great Divide drainage basin; however, a very small portion of the ARPA drains into Little Sage and Sugar Creeks, tributaries of the North Platte River. The total CIA area is approximately 6,913,600 acres in size. The CIA

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

area includes the Creston/Blue Gap, Continental Divide/Wamsutter II, and South Baggs EIS study areas that fall entirely within the Little Snake River drainage and Great Divide basins.

Cumulative disturbance within the watershed CIA area includes estimated disturbance associated with the Atlantic Rim project and existing and future disturbance associated with those portions of the Creston/Blue Gap, Continental Divide/Wamsutter II, and South Baggs projects located within the Little Snake River and Great Divide drainage areas. No other permitted projects or RFFAs within the CIA area are reasonably foreseeable at this time.

5.1.4 Regional CIA Area

The regional perspective is useful primarily for the analysis of air quality and socioeconomic impacts. The south half of Wyoming, northern Colorado, and northeast Utah region includes extensive oil and gas development; grazing and ranching; recreational development and dispersed recreation use; coal and trona mining; soda ash, fertilizer, and electric power production; and other residential, commercial, and industrial development. There are also several highways, and major railroad and Interstate 80, which must be considered in the analysis of cumulative air quality impacts.

5.2 Potential Cumulative Impacts by Resource

5.2.1 Geology/Minerals/Paleontology

With the exception of petroleum resources, the geology and mineral resources within the ARPA have not been significantly affected by present and existing activities and are not anticipated to be notably affected by the Proposed Action or the alternatives if mitigation measures specific to resources are adopted. Therefore no cumulative impacts are anticipated for geology or mineral resources other than oil and gas and potentially construction materials. As discussed in section 4.1, successful oil and gas and CBNG development would result in natural gas production and depletion which is the purpose of this proposal and not considered an adverse impact. In addition, as discussed in that same section, construction-grade materials are likely to be used from local sources for surfacing materials (gravel) for petroleum and CBNG facilities in the ARPA and other areas. If development is extensive, known accumulations of local materials may become depleted and additional sources would need to be identified and used.

Potential cumulative impacts to paleontology include cumulative loss of scientifically significant resources at both known and as-yet undiscovered fossil localities. Fossil localities producing scientifically significant vertebrate fossils are rare and unevenly distributed through rocks that occur in the ARPA and adjacent areas of southern Wyoming. Those that yield fossils of great scientific importance are extremely rare. Several such localities are known from the ARPA and others may exist that have yet to be discovered within the ARPA as well as adjacent parts of southern Wyoming. These localities may preserve rare and scientifically significant fossils including remains of species not yet known to science or more complete specimens of known species.

The magnitude of the potential impact increases as additional oil and gas development projects are permitted in southwestern Wyoming on federal, state, and private lands that have not been evaluated for paleontology. Once a fossil locality that produces significant resources is lost by excavation or buried it is effectively removed from the possibility of scientific study and that information is lost.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Cumulative beneficial consequences, including the recovery of scientifically significant fossil resources at known and as-yet undiscovered fossil localities, could occur anywhere in the project area. To be most beneficial, a site-specific mitigation plan for recovery and curation of newly discovered specimens and recording associated geologic data should be adopted.

5.2.2 Climate and Air Quality

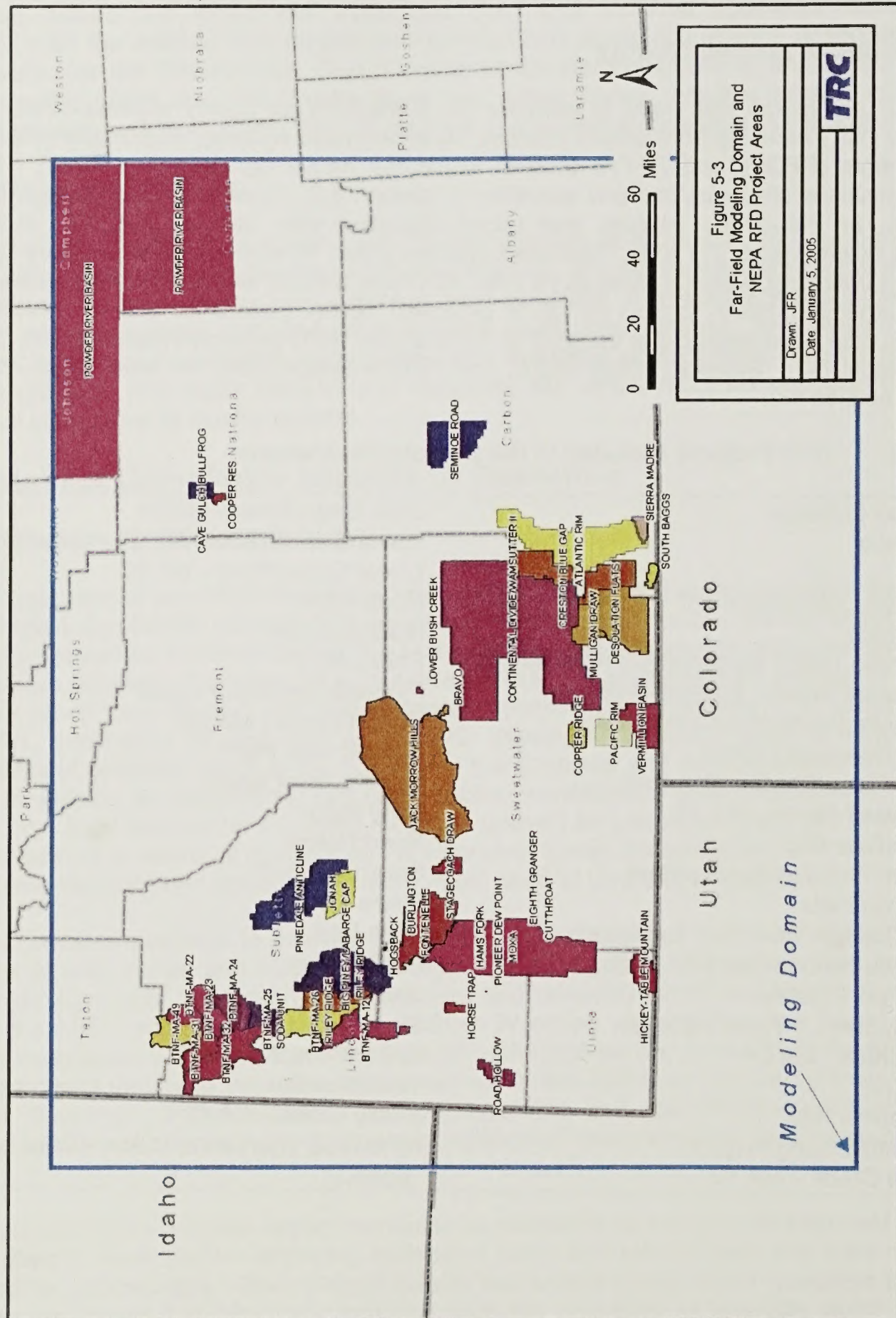
The CALPUFF model was used to estimate the cumulative air quality impacts of NO_x, SO₂, PM₁₀, and PM_{2.5} resulting from project sources, state-permitted sources, reasonably foreseeable developments (RFDs), and RFFAs located within the model domain (map M-44). Project source emissions are described and quantified in section 4.2. State-permitted sources include NO_x, SO₂, or PM₁₀/PM_{2.5} sources that began operation after January 1, 2001, and were permitted before March 31, 2004. Sources permitted within 18 months before January 1, 2001, but not yet operating, were included as RFFAs. RFD was defined as the undeveloped portion of (1) an authorized NEPA project or (2) a proposed NEPA project for which quantified air emissions data were available at the time of the analysis. RFD projects included in the CIA are listed in table 5-1. State-permitted RFFA, and RFD emission rates modeled in the CIA are shown in section 4.2.

Table 5-1. RFD Projects Included in the Cumulative Analysis.

Big Piney-LaBarge	Little Greys River - MA 31
BTA Bravo	Lower Bush Creek CBM (Kennedy Oil)
Burley	Lower Greys River - MA 32
Burlington Little Monument	Moxa Arch
Cave Gulch	Mulligan Draw
Cliff Creek - USFS Management Area (MA) 22	Pacific Rim
Compressor Station, Pipeline- Williams	Pinedale Anticline Project
Continental Divide/Wamsutter II EIS	Piney Creeks - MA 26
Cooper Reservoir (1998)	Pioneer Gas Plant
Copper Ridge Shallow Gas Proj.	Powder River Basin
Cottonwood Creek - MA 25	Riley Ridge
Creston-Blue Gap	Road Hollow
Cutthroat Gas Processing Plant	Seminole Road
Desolation Flats	Sierra Madre
Eighth Granger Gas Plant Expansion	Soda Unit
Fontenelle Natural Gas Infill Drilling	South Baggs
Ham's Fork Pipeline	South Piney
Hickey Mountain-Table Mountain	Stage Coach
Horse Creek - MA 24	Upper Hoback - MA 23
Horse Trap	Vermillion Basin
Jack Morrow Hills	Willow Creek - MA 49
Jonah Infill Drilling Project	Wind River (Bureau of Indian Affairs lead agency)
LaBarge Creek - MA 12	

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Map M-44. Far-Field Modeling Domain and NEPA RFD Project Areas.



CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

While there may be additional gas processing or transmission requirements due to the development of this and other natural gas projects regionally and nationally, the potential effects of these developments are not quantified herein since these developments are speculative and would likely require additional WDEQ-AQD permitting if they eventually are proposed. A portion of the Powder River Basin Oil and Gas Development Project (PRBP), located approximately 68 miles east-northeast of the ARPA, is located within the far-field modeling domain. A ratio of total PRBP field development equal to the geographical portion within the ARPA far-field modeling domain was included as an RFD in this analysis. The PRBP identified significant project-specific and cumulative potential impacts in the Bridger Wilderness and other sensitive areas also analyzed for this project. Further information on potential air quality impacts associated with the PRBP may be found in the PRBP EIS Technical Support Document prepared by BLM (USDI-BLM 2002d).

Cumulative potential impacts were analyzed at each of the nine Class I and sensitive Class II areas listed and at in-field locations within the ARPA. Ambient concentrations were estimated at each Class I and sensitive Class II area and at locations within the ARPA, and were compared to applicable ambient air quality standards and PSD increments. Atmospheric deposition calculations were performed for each Class I and sensitive Class II area and at acid-sensitive lakes within these areas. Cumulative deposition was used to compute ANC change, which was compared to applicable LACs for each of the analyzed acid sensitive lakes. Total deposition impacts (cumulative impacts plus background) at Class I and sensitive Class II areas were compared to USDI-FS levels of concern, 5 kg/ha-yr for sulfur and 3 kg/ha-yr for nitrogen. Visibility (regional haze) potential impacts were computed for each Class I and sensitive Class II area. Potential changes in regional haze were estimated using CALPUF-modeled impacts and two sets of background visibility conditions, FLAG and IMPROVE, as described in section 4.2. Potential changes to regional haze were compared to a 1.0 dv threshold.

5.2.2.1 Proposed Action Far-Field Cumulative Impacts

Maximum potential cumulative impacts of NO₂, SO₂, PM₁₀, and PM_{2.5} were estimated for each of the analyzed PSD Class I and sensitive PSD Class II areas. These potential impacts were added to ambient background pollutant concentrations for comparison to the WAAQS, CAAQS, and NAAQS. The predicted potential cumulative impacts are below applicable ambient air quality standards and PSD increments.

Potential visibility impacts are predicted to be above the "just noticeable visibility change" (1.0 dv) threshold at the Bridger Wilderness Area and Popo Agie Wilderness Area using the FLAG background visibility data and at Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area using the IMPROVE background visibility data. Potential visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

The maximum potential visibility impacts are primarily a result of the cumulative "non-project" regional source emissions. The maximum direct project potential visibility impacts (0.2 dv), as described in section 4.2, were estimated to be less than the 1.0 dv threshold. In addition, as defined in the FLAG report, a 0.4-percent change in extinction (0.04 dv) is considered a project-specific significance level for cumulative visibility analyses. Specifically, if the direct project contribution to a cumulative potential visibility impact of 1.0 dv or greater is less than 0.04 dv, the project is regarded as having an insignificant contribution to the cumulative visibility impact. Additional analyses were performed following the FLAG report criteria for visibility significance

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

determination. The results of this analysis indicated that for all days where the cumulative (project and regional sources) potential visibility impact was 1.0 dv or greater, the direct project potential impacts were below the 0.04 dv significance threshold. Based on these results, the Atlantic Rim project emissions would not cause or contribute to any significant visibility degradation at any of the Class I and sensitive Class II areas.

Potential cumulative atmospheric deposition impacts at the fourteen sensitive lakes are below the ANC LACs. In addition, cumulative total nitrogen and sulfur depositions are well below the 5-kg/ha-yr (for sulfur) and 3-kg/ha-yr (for nitrogen) LOCs.

5.2.2.2 Proposed Action In-Field Cumulative Impacts

Model-predicted concentrations of NO₂, SO₂, PM₁₀, and PM_{2.5} at locations within the ARPA resulting from Proposed Action and regional source emissions were added to monitored background concentrations and compared to ambient air quality standards. The estimated potential cumulative impacts from project and regional sources were below applicable ambient air quality standards.

5.2.2.3 Alternative A (No Action) Far-Field Cumulative Impacts

The CALPUFF modeling performed and reported in the Technical Support Document for Alternative A assumed no field development within the ARPA beyond levels currently authorized. Far-field CALPUFF modeling performed for the Proposed Action, which included emissions from project sources and from inventoried regional sources within the model study domain, indicated that while project sources contributed insignificantly to total far-field impacts, regional sources were the primary contributors to far-field impacts.

5.2.2.4 Alternatives C and D Far-Field Cumulative Impacts

The cumulative analysis performed for the Proposed Action modeled ARPA sources under a worst-case scenario, assuming one full year of construction in conjunction with nearly full-field development. Alternative C and D air emissions would be equal to or less than those which would occur under the maximum scenario analyzed for the Proposed Action. Furthermore, all other state-permitted sources, RFDs, and RFFAs would be identical to those analyzed for the Proposed Action and shown on map M-44. Model results from the Proposed Action indicated that while project sources contributed insignificantly to total far-field impacts, regional sources were the primary contributors to far-field impacts.

Cumulative impacts of NO₂, SO₂, PM₁₀, and PM_{2.5} from Proposed Action sources and inventoried regional sources within the model study domain, when added to ambient background pollutant concentrations, would be below applicable ambient air quality standards and PSD increments. Potential cumulative visibility impacts analyzed for the Proposed Action are predicted to be above the "just noticeable visibility change" (1.0 dv) threshold at the Bridger Wilderness Area and Popo Agie Wilderness Area using FLAG background visibility data, and at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area using IMPROVE background visibility data. Potential cumulative visibility impacts from the Proposed Action at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days. Potential cumulative atmospheric deposition impacts from the Proposed Action at the fourteen sensitive lakes would be below the ANC LACs. In addition, cumulative total nitrogen and sulfur deposition would be below the 5 kg/ha-yr (for sulfur) and 3 kg/ha-yr (for nitrogen) LOCs.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

5.2.2.5 Unavoidable Adverse Impacts

Some increase in air pollutant emissions would occur as a result of the Proposed Action and regional source emissions. Near-field potential impacts from these emissions are predicted to be below applicable significance thresholds. However, there is a potential for cumulative visibility potential impacts to exceed visibility thresholds within PSD Class I Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area. The Proposed Action is regarded as having an insignificant contribution to the cumulative visibility impact.

5.2.3 Soils

Existing and cumulative disturbances within the ARPA are described in section 5.1.1 for the various alternatives. For all alternatives, the cumulative post-reclamation disturbances are relatively low, and the successful implementation of erosion, runoff, and sediment controls and revegetation measures described in section 4.3 and the Reclamation Plan (appendix B) would reduce the contribution of the Proposed Action or the alternatives to cumulative impacts on soil resources. These would not remove the impact. Locally, there would still be areas exceeding the significance criteria, which would be combined with those areas outside this project area that are also exceeding the significance criteria. New development adjacent to this project area would also contribute to the increased erosion and sedimentation within the watersheds. The action alternatives could add to the cumulative removal of biological soil crusts within the area. The cumulative impact on soil crusts cannot be fully predicted due to the lack of inventory data. Initial reconnaissance has shown them to be scattered and mostly not well developed.

The ARPA contains such a small portion of the North Platte River drainage that even cumulative impacts are insignificant. Erosion within the Great Divide Basin is generally low and site-specific due to terrain. Also, because there are no drainage outlets, erosion does not affect any other watersheds. The upper Colorado River drainage has listed both salinity and sediment as significant factors for many years. Water quality sampling in the 1980s documented the Muddy Creek drainage as the principle source of sediment for the upper Little Snake River. Conservation efforts over the past 20 years have achieved success in improving watershed cover and riparian health while reducing soil erosion, in part using 319 Clean Water funding from the USEPA. These efforts have focused for the most part on livestock management; however, watershed assessments identified increased sedimentation due to oil and gas development (primarily due to runoff from roads). This project, along with other adjacent oil and gas development, would only lead to increased and accelerated erosion, and exacerbate sedimentation (and salinity) issues within the upper Colorado River drainage.

5.2.4 Water Resources

Cumulative impacts include water resource impacts from ongoing activities, RPDs, and RFFAs. Cumulative impacts are assessed for the ARPA and the watershed CIA area that includes the Little Snake River, the Great Divide, and a very small part of the North Platte River drainage areas.

5.2.4.1 ARPA Cumulative Impact Analysis Area

Existing and cumulative surface disturbances within the ARPA are described in section 5.1 for all the alternatives.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Ranch management, grazing activities, and other resource uses within the EIS analysis area would be required to meet Standards for Healthy Rangelands (USDI-BLM 1997) and therefore are not expected to have measurable effects to surface water resources. Because livestock tend to concentrate around stock ponds and in drainage areas in search of water, there would be localized effects to surface waters, which could lead to greater erosion where surface disturbance occurs and livestock concentration areas coincide.

Recreational activities, such as fishing, hunting, and camping, would continue to have minimal effects on surface water, but could be more pronounced in localized areas due to off-road travel and potential additional access provided by the project. Off-road travel in drainage areas will cause local effects to surface waters, but these effects would be limited in the EIS analysis area given restricted travel through the checkerboard federal and private ownership of many of the lands. Where there is continuous federal land and the project improves or creates new access, these impacts could be significant depending on the alternative selected.

No serious groundwater pollution problems have been detected in the watershed CIA area. Current oil and gas exploration and development activities must comply with federal and state environmental quality laws; thus, serious water quality and quantity impacts are not expected on a cumulative scale.

5.2.4.2 Watershed Cumulative Impact Analysis Area

Downstream demands for water in the Little Snake River drainage would continue to influence water management in the basin. Additional reservoir construction and associated irrigation systems would most likely be constructed with regard to the Yampa River Basin Management Plan and the recovery program for Colorado River native fish downstream (<http://www.r6.fws.gov/crrip/>). In addition, regional surface water quality would continue to be influenced by local and regional land use trends and activities, which include ranching and farming, oil and gas exploration and development, coal mining (none currently planned), and recreational use. Irrigation activities and municipal water systems below the ARPA would contribute additional salt loading into the Colorado River system.

Surface discharge using the offsets at the Cow Creek Pod can be expected to continue through the life of the project according to the WYPDES permits #WY0042145 and #WY0035858, which allow for 1.34 tons/day of salts and 180,600 gallons/day of total discharge under both permits. As described in chapters 3 and 4, this is an offset for an oil well (as defined by the Colorado River Salinity Control Forum), and the permit allows for the same volume of water and salt as was discharged by the oil well plugged (#1X-12). This discharge is into a reservoir on a tributary of Dry Cow Creek. This reservoir will be improved and maintained according to this use. The discharge permit is currently being revised to allow for water releases from the reservoir in a similar manner as what occurred historically when #1X-12 was in operation. The permit has a point of compliance upstream of the confluence with Cow Creek that should not allow water from the project to enter Cow Creek.

The proposed action did not propose any surface discharge of produced water from non-federal leases into facilities on private land. It is therefore assumed that all water produced from the coal formation would be re-injected with the exception of off-set uses for flowing wells as described for Cow Creek. Therefore, the WDEQ permit #WY0048437 for the Doty Mountain Pod would not be used.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

A recently approved WYPDES permit for treated surface discharge of water (WDEQ permit #WY0054038) can be described as a pilot project. This discharge was permitted under the freshwater waiver conditions for the Colorado River Salinity Forum and would require treatment of the water to below 500 mg/L. BLM is considering this discharge under a separate analysis to determine significance. If the proposal is determined to be significant, a separate EIS will be required. If surface discharge of water becomes a significant method for produced water disposal in the ARPA, separate analysis may be needed that would consider the entire ARPA. This EIS does not consider any method of disposal besides injection and the offsets described above.

This project allows for closed system livestock or wildlife watering facilities under all alternatives subject to state permitting. Water from CBNG wells can be used for construction and drilling activities, subject to state permits. Owners of any state-permitted water wells documented to be impacted by the project would be offered a well water agreement to mitigate any drawdown impacts (See appendix H).

Additional oil and gas exploration and development will occur in the areas within and surrounding the EIS analysis area. Cumulative post-reclamation disturbances would be a significant impact to surface water as discussed under section 4.4. Combined impacts from the Creston Blue Gap area combined with the Atlantic Rim project can be expected to change the surface runoff characteristics above background levels and would likely be detrimental to the Muddy Creek section west of WY 789 listed as having threats on the State of Wyoming 303d list. Furthermore, salt and sediment contributions to Muddy Creek from these projects can be expected to increase above background levels due to surface disturbance. This increase would impact the Colorado River Basin with a portion contributing to the Little Snake River, as more conservative salts move downstream and sediments are stored in local channels.

Current water usage in the general area of the ARPA from all combined surface water and groundwater sources is estimated to be approximately 90,000 acre-feet per year (Collentine et al. 1981). This estimate includes uses outside the watershed CIA. Using this estimate as an environmentally conservative indication of total existing water usage, the Atlantic Rim project under the Proposed Action would use approximately 1,100 acre-feet of water. Because the Creston/Blue Gap, Continental Divide/Wamsutter II, and South Baggs project areas fall entirely within the Little Snake River and Great Divide Basins, 100 percent of the total water usage from these projects within the watershed CIA (approximately 2,700 acre-feet, 7,000 acre-feet, and 150 acre-feet, respectively) could be as much as 11,000 acre-feet over the life of the projects. If the total water usage from the Desolation Flats project (approximately 900 acre-feet) is included, even though it falls outside the watershed CIA, the total water usage for the general area could be as much as 12,000 acre-feet or approximately 13 percent of the current water usage in the general area. This cumulative water usage estimate is relatively small because it would be distributed over the lives of these projects. Also, much of the water use for the ARPA will be from coal formations.

5.2.5 Vegetation and Wetlands

5.2.5.1 ARPA Area

All the action alternatives would add to the cumulative removal of vegetation within the area. Because of the widespread distribution and abundance of the mountain and Wyoming big sagebrush cover types in the project area and south-central Wyoming, minor reductions in these

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

upland cover types would not be a significant impact following successful reclamation and the long-term reestablishment and establishment of native shrubs. Vegetation cover types such as alkali sagebrush and silver sagebrush/bitterbrush could be significantly impacted by disturbance due to their low abundance across the region.

Wildfires in this area occur infrequently and are usually of such small size that they add about 100 acres annually to the total amount of disturbed vegetation. There has only been one large wildfire in the general area within the last 30 years, occurring in 1993 in the Sand Hills, which burned 2,900 acres. These areas recover quickly with herbaceous species, but more slowly with shrubs and trees. Prescribed burns have primarily occurred in mountain big sagebrush sites. In limited cases, prescribed burns have occurred in aspen, mountain big sagebrush/mountain shrub mix, and basin big sagebrush cover types. The timing and conditions at the time these treatments are executed are beneficial in terms of stimulating species to improve their health, or in the case of sagebrush helping to reoccupy these habitats within 20 to 30 years instead of a longer time span. Future prescribed burns would need to factor other developments into both long-term objectives and the size and management of treatments, and would likely lead to more chemical and mechanical treatments.

The combination of activities that require reclamation and vegetation treatments increase the amount of acreage dominated by herbaceous vegetation versus those dominated by shrubs. In general, this would affect 5 to 10 percent of the overall landscape. Recovery of habitat functionality for shrubs in treatments generally occurs within 30–50 years; whereas, recovery of shrubs in reclamation tends to take longer. Because the majority of shrubland and woodland cover types consist of mature to overmature woody plants, which increases the amount of early succession, it is desirable to include younger-aged stands to diversify cover and age-class structures. Currently, there is a lack of native seed sources for forbs (and some grasses and shrubs) to use in reclamation, particularly in the 7- to 9-inch precipitation zone. This lack of seeds will continue to prevent meeting long-term species composition objectives.

Indirect effects from the action alternatives would come from road issues of dust and desertification that increase in a cumulative manner with adjacent existing and proposed oil and gas development. Dust accumulation on vegetation, reduced photosynthetic activity and growth, and lower palatability for herbivores would result in long-term alteration of species composition, cover, and productivity. If not mitigated, these impacts could affect 20–35 percent of the region and include all vegetation cover types. Desertification impacts from road modification of upland hydrology would also increase on a cumulative basis, but in more site-specific areas. In generally flat to gently rolling terrain, these impacts would be minimal, but in the Flattops, Powder Rim, and Willow Creek areas, these impacts would be similar to the ARPA with one-third or more of the area affected.

The invasion and establishment of invasive weed species has already resulted in an increase to the local and regional cumulative effects of undesirable plant species in native ecosystems. This project would contribute cumulatively to the local and regional invasive weed populations. An aggressive and constant-monitoring program by all involved parties (federal, state, county, and private) would be mandatory to contain or prevent this threat. Operators would coordinate and support county weed and pest districts to help control the introduction and spread of weeds resulting from the operator's activities.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

5.2.5.2 Watershed CIA Area

On the broader scale of watersheds, there would be negligible impacts to vegetation within the North Platte River drainage and minimal impacts to vegetation in the Great Divide Basin. Cumulative impacts in the upper Colorado River drainage would be low to moderate due to dust and desertification from roads and their influence on overland hydrology. These alterations would affect 5 to 10 percent of the drainage within the upper Little Snake River and relate to long-term reduction of vegetative cover, species diversity, and productivity, primarily in the Wyoming big sagebrush cover type. However, due to the wide range of this species, overall impacts would be low. The acreage of vegetation disturbance due to permitted activities and naturally occurring events would be less than 2 percent of the overall landscape.

Cumulative impacts also include wild horses in the Adobe Town HMA. Although not in the ARPA, this management area overlaps the southern portion of oil and gas field development west of WY 789. Lack of funding for roundups led to population increases through 2002 and 2003 resulting in forage consumption by wild horses equal to that normally consumed by wild horses and livestock combined. Because of concurrent drought conditions, species composition decreased, vegetation cover decreased, and plant spacing increased, which will require years for recovery. Roundups in 2003 and 2005 have returned wild horse numbers to desired levels, but if allowed to expand to the high numbers recently observed, it would have negative affects on reclamation, weeds, and erosion, in addition to the affects already described above.

5.2.6 Range Resources

5.2.6.1 ARPA Area

In the long-term, cumulative impacts to the grazing resource would likely result in a small net loss in total annual forage production. This small decrease in quantity, assuming successful revegetation occurs, would be offset by an increase in quality that would be provided by a younger and more nutritious herbaceous cover. Although native shrubs would re-establish in the long-term, dominance of herbaceous vegetation would benefit livestock operations that currently run 90 percent cattle, whose diets are primarily grasses. Dust impacts to vegetation would lower palatability. Lowered palatability would cause health and weight gain issues like dust pneumonia, which are larger issues than direct loss of vegetation. On a cumulative basis, these impacts would increase, but the actual affect to each operation would depend on the operation size and how much of the operation was included within a development area. These impacts would occur in both the development and production phases of oil and gas development.

The more important impacts to grazing relate to disruptions to livestock management, damage to facilities, and death loss of animals to collisions and poisonous plants. The first two relate more to the development phase and can be minimized with adequate consultation. Unfortunately, the scope of this impact is not well understood by people or documented in terms of actual impact. For instance, in 2005, one operator had to roundup cattle three times rather than once from a 60,000 acre allotment and neighboring allotments due to pipeline construction and open fences. In 2006, this same allotment had fifteen fence locations cut by new pipelines and roads that were not adequately rebuilt to contain cattle when the grazing season started. These types of problems increase labor costs, reduce weight gains, increase potential disease transmission, and reduce time available for other planned work. Animal death loss can occur at anytime, but can also be minimized with adherence to standard compliance stipulations.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

However, improved roads often just lead to greater vehicle speeds and potential for collisions with animals. The weeds issue is more serious for sheep producers due to the death loss from halogeton. This invasive species has not been adequately controlled and is expanding with new disturbances, increasing sheep death loss and reducing the grazing land available that is free of halogeton. Whether this issue alone would eliminate economic sheep operations in this area is unknown, but currently this issue is the greatest threat to these operations.

In summary, impacts to livestock operations include the above factors, but the level of impact will be dependent on the rate and extent of development upon each ranch. Development at a slower pace allows operators to keep up with what is happening and deal with problems as they arise. Development in one pasture or one allotment at a time still allows operators to work around development to minimize disruptions. However, the pace of development tends to be faster rather than slower, and 80 percent of the grazing operators run entirely within oil and gas development areas, limiting options for grazing operations. Under this scenario, there is likely to be both reduced grazing use and in some cases requests for total non-use by the operator for up to 5 years during the development phase. Once field development is completed and the production phase begins, livestock grazing would likely return to initial levels of use.

5.2.6.2 Watershed CIA Area

Expanding the area for cumulative analysis of impacts to livestock operations does little to change the analysis above. If operators reduce their animal numbers or duration of use or if they request total non-use to avoid disruptions due to oil and gas development, some additional grazing use could occur in areas not affected by this development. This could be in watersheds within the CIA area or in others further distant. However, this would likely only be during the next 5 to 10 years and not continue once gas field operations became primarily production orientated.

As described above under section 5.2.5, the population of wild horses in the Adobe Town HMA could affect livestock operations under cumulative impacts with oil and gas development. If populations of wild horses are allowed to expand beyond desired population levels, flexibility of livestock operations to adjust to impacts from oil and gas development would be reduced. In the case of the 2003 and 2004 grazing seasons, nearly all livestock use (24,000 AUMs) was eliminated due to impacts from wild horses and the 2002 drought. If this situation reoccurs in conjunction with responding to management disruptions related to oil and gas development, additional reductions in livestock use may be required.

5.2.7 Wildlife

The CIA areas for wildlife resources differ with respect to species. This analysis examines the proportion of the wildlife habitat within respective CIA areas that may be disturbed from all past, present, and RFFAs. In assessing cumulative impacts, it was not possible to specifically determine where future impacts would occur within CIA areas. Therefore, estimates of total disturbance were made based upon the location of past, present, and known future projects within the CIA areas and the expected amount of disturbance associated with each project. The proportion of the estimated total disturbance within the CIA areas was used to estimate the cumulative area of wildlife habitats that may be disturbed by past, present, and RFFAs.

The combination of the individual projects is resulting in a large area of increased fragmentation, disturbance of wildlife and their habitats, and the loss of refuge areas. Additional effects are

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

expected upon wildlife dispersal, the reduction of non-fragmented habitats, competition with livestock, and inter- and intra-specific competition with other wildlife species. The generalized increase of human presence and associated disturbance across such a broad scale are a concern. Remaining ranges with increased competition for forage leading to reduced carrying capacity and juvenile survival can also be expected. Mitigations, COAs, and other BMPs will reduce the impacts of these developments, but not eliminate them. Reduced populations and population viability can be expected.

Cumulative indirect effects from the Proposed Action or alternatives to all wildlife species in general would come from roads and traffic noise. As roads are developed within and adjacent to the project area, habitat is fragmented. Roads can serve as barriers to some animal movement. The displacement of species away from roadsides can be reasonably predicted. Insects, birds, and amphibians all avoid dust and noise from roads, which compounds impacts to adjacent habitats throughout the CIA area. Sagebrush-obligate species would be affected by the cumulative removal of habitat (reduction or fragmentation of patch size or vertical habitat structure) throughout the area.

5.2.7.1 Big Game

Construction such as building well pads and roads can reduce use of surrounding habitat by wildlife. Although this construction reduces forage due to the direct loss of native vegetation, there is an area surrounding these sites that tends not to be used due to increased human activity. This "zone" can extend up to 0.625 miles from the developed area for pronghorn (Easterly et al. 1991) and from 0.6 to 1.2 miles for elk depending upon the season (Powell 2003). Consequently, disturbance to wildlife can extend further off site than the actual disturbed area. Some individual animals can habituate to the increased infrastructure; however, it is generally assumed that, overall, the increased human presence in an area is detrimental to big game species. Dust accumulation on vegetation lowers the palatability for big game. This, along with the physical removal of vegetation, reduces the availability of forage. The significance of this forage reduction is greater in big game crucial winter range, especially as development cumulatively and concurrently occurs outside the project area in adjacent oil and gas development areas.

Big game populations are managed within herd units designated for each species and cumulative impacts are discussed in the context of these areas. Cumulative big game habitat losses for pronghorn, mule deer, and elk herds resulting from development of the ARPA, and adjacent EIS areas (section 5.1) are presented in table 5-2. Implementation of the proposed project would affect crucial winter/yearlong and winter/yearlong range for all three big game species. The specific locations of future disturbances within the ARPA and the remainder of the herd units are unknown; therefore, the area of each type of seasonal big game ranges that may be impacted is unknown. The potential impacts to big game habitats are estimated for the portions of each herd unit that contain designated big game seasonal ranges. The cumulative disturbance to big game seasonal ranges expected to result from development activities from the combination of existing, proposed, and RFFA disturbances for each of the three big game species are listed in table 5-2. Cumulative impacts to big game would include permanent, short-term, and long-term loss of habitat. It would also include increased stress due to human/wildlife encounters, potential reductions in birth/survival rates, and possible alterations of migration routes.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Table 5-2. Estimated Cumulative Surface Disturbance (acres) within Big Game Seasonal Ranges, Included within the ARPA.

		Project Related Development		Cumulative Development ^{1,2}		Total Disturbance
	Acreage Available	Initial	LOP	Existing	Potential Future	Acres
Pronghorn – Baggs Herd Unit						
Proposed Action	890,743	15,800	6,241	5,804	743	12,788
No Action (A)	890,743	0	0	5,804	743	6,547
Alternative C	890,743	15,800	6,241	5,804	743	12,788
Alternative D	890,743	13,000	5,000	5,804	743	11,547
Mule Deer – Baggs Herd Unit						
Proposed Action	1,843,543	15,800	6,241	23,536	17,751	47,528
No Action (A)	1,843,543	0	0	23,536	17,751	41,287
Alternative C	1,843,543	15,800	6,241	23,536	17,751	47,528
Alternative D	1,843,543	13,000	5,000	23,536	17,751	46,287
Elk – Sierra Madre Herd Unit						
Proposed Action	1,525,644	15,800	6,241	883	0	7,124
No Action (A)	1,525,644	0	0	883	0	883
Alternative C	1,525,644	15,800	6,241	883	0	7,124
Alternative D	1,525,644	13,000	5,000	883	0	5,883

Notes:

¹ Sources: Creston/Blue Gap EIS (USDI-BLM 1994), Continental Divide/Wamsutter II (CD/WII) EIS (USDI-BLM 2000a), Desolation Flats EIS (USDI-BLM 2003g); these numbers do not reflect acreage disturbed within the ARPA from existing natural gas development or the Interim Drilling Policy.

² Numbers reflect reclaimed acreage, not total shrub habitat loss as a result of the projects, therefore, the numbers are conservative.

Pronghorn. The cumulative impact analysis area for pronghorn is the herd units impacted by the project. Cumulative impacts upon pronghorn migration routes are unknown at this time; however, the current fencing along WY 789 creates a barrier to pronghorn attempting to migrate across this highway. Wyoming Game and Fish Department has constructed a lay down fence along a portion of this area.

It is assumed that most, if not all, of the Baggs herd transition range is located within the ARPA. The Baggs Herd Unit has 43.5 percent of its crucial winter range located within the ARPA (map M-21). An additional 39.6 percent of this herd unit's crucial winter range lies within other oil and gas project EIS boundaries adjacent to the ARPA. Therefore, 83.1 percent of the Baggs pronghorn crucial winter range may lie within one or more of several oil and gas project boundaries.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Mule Deer. The cumulative impact analysis area for mule deer is the herd units impacted by the project. Cumulative impacts upon mule deer migration routes within the Baggs Herd Unit are unknown. Currently, an industry sponsored mule deer study is ongoing. Completion of the first phase of the study has provided BLM and WGFD better information on migration routes. It is assumed that most, if not all, of this herd's transition range is located within the ARPA. The Baggs Herd Unit has 27 percent of its crucial winter range located within the ARPA. An additional 23.3 percent of this herd unit's crucial winter range lies within other oil and gas project EIS boundaries adjacent to the ARPA. Therefore, 50.3 percent of the Baggs mule deer crucial winter range might lie within one or more of several oil and gas project boundaries.

Elk. The cumulative impact analysis area for elk is the herd units impacted by the project. The Sierra Madre Herd Unit has 25 percent of its crucial winter range located within the ARPA (map M-24). No additional acreage of this herd unit's crucial winter range lies within other oil and gas project EIS boundaries adjacent to the ARPA. It is assumed that a portion of this herd's transition range is located along the eastern third of the ARPA. Current collaring studies within the ARPA by the WGFD show more movement of elk in a north-south direction along the eastern third of the ARPA than was originally suspected. However, elk movement may not always be the most direct route from winter to summer range. It is likely that project activities will disturb elk to a degree that they may move to new areas outside the ARPA. Elk are more sensitive to human activities than Mule Deer or Pronghorn Antelope, and may be displaced up to 1.2 miles, depending on the season (Powell 2003). This displacement could have consequences for livestock operators and other wildlife habitat.

5.2.7.2 Greater Sage-Grouse and Columbian Sharp-Tailed Grouse

Greater sage-grouse inhabit the ARPA and surrounding area year-round and require a wide range of seasonal habitats. The ARPA is located primarily within the Sierra Madre Upland Game Bird Management Area (UGBMA), but a small section is also located in the Bitter Creek UGBMA. These two areas were used as the CIA area for greater sage-grouse breeding and nesting habitats.

There are a total of 185 greater sage-grouse leks (150 occupied, 14 unoccupied, and 21 with unknown status) within the Bitter Creek and Sierra Madre UGBMAs. The area of potential nesting habitat consists of a 2-mile buffer placed around all occupied and unknown status leks within the Bitter Creek and Sierra Madre UGBMA. This area encompasses an additional 662,080 acres outside the ARPA, which is within EIS boundaries that have current, and could receive future, oil and gas development.

There are 145 greater sage-grouse leks within a 2-mile buffer of all current EIS project boundaries for oil and gas development including the ARPA. This project would cumulatively increase the leks potentially impacted by 88 leks. Furthermore, within the boundaries of the South Central Conservation Area (SCCA), 45 percent of this area's grouse are found within a 2-mile buffer of these same EIS boundaries and 28 percent are found within a 2-mile buffer of the ARPA. Data collected at seven sites in Wyoming documented that 45 percent of nests occur within 2 miles of a lek and that 64 percent of nests occur with 3 miles of a lek. In addition, nest success probability suggests increased nesting success rates beyond 5 miles of a lek (Holloran 2005). Until all existing and suitable habitat is mapped within the ARPA beyond the 2-mile lek buffer, there is a potential to have a significant direct and indirect impact to grouse.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Within Wyoming nearly half of the leks found within the SCCA are within oil and gas fields being developed. Development might cause bird displacement and nest abandonment from direct and indirect impacts, such as habitat fragmentation, dust, noise, human activities, and long term loss of sagebrush habitat. These direct and indirect impacts would be cumulatively significant and would lead to lower productivity and a long-term decline in the population of this species.

Columbian sharp-tailed grouse inhabit the ARPA along the eastern edge and southern portions. The only populations found within Wyoming are within and adjacent to the ARPA. Wyoming's populations are a northern extension of those found within northwestern Colorado (133 leks). Currently, there are 27 leks in Wyoming, all of which occur on or within 16 miles of the east ARPA boundary. Only seven of these leks are afforded protection (BLM or USDI-FS); the remaining 20 leks are found on state or private lands. Cumulative impacts to sharp-tailed grouse may occur from current and future county land use planning and community development, loss of Conservation Reserve Program (CRP) lands, mining and energy development in Colorado (Hoffman 2001). This development may cause bird displacement and nest abandonment from direct and indirect impacts, such as habitat fragmentation, dust, noise, human activities, and long term loss of mixed shrub habitat. These direct and indirect impacts would be cumulatively significant and would lead to lower productivity and long-term decline in the population of this species.

5.2.7.3 Raptors

The CIA area for raptors includes the ARPA plus a 1-mile buffer. This area covers approximately 400,000 acres, all of which would be considered raptor foraging habitat. Approximately 290,000 acres of this area were located within 1 mile of a known raptor nest and are considered to be potential raptor nesting habitat.

Cumulative impacts from the creation of additional nesting sites (artificial nesting structures and tanks) are unknown from other conventional oil and gas EIS projects in the vicinity of the ARPA. In the Continental Divide/Wamsutter II EIS area, raptor nesting success is static to improving. In addition, raptor fledgling numbers increase from three per natural nest to four per artificial nest. Additional research is needed to evaluate impacts on raptors and their prey by creating additional nesting structures in areas that previously were limited by natural nesting substrates.

5.2.8 Special Status Plant, Wildlife, and Fish Species

Potential impacts to threatened, endangered, proposed, and sensitive species in this area of Wyoming are likely to be primarily associated with minerals development.

5.2.8.1 Plants

The area of influence assessed for special status plants includes the area described in section 5.1.2, southeastern Sweetwater County and southwestern Carbon County. Indirect concerns across the assessment area includes the possibility of a general reduction or loss of pollinators, invasion of weeds from adjacent development into occupied habitats, and increased risk of habitat disturbance from increased human presence.

Given the BLM policy of avoiding disturbance activities within identified special status plant habitats, direct cumulative effects upon these species should be avoided. While no special status plant populations are known to exist within the ARPA, site-specific surveys will be

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

conducted for each disturbance proposal to identify any unknown populations at risk from development. Standard mitigation and BMPs will allow for avoidance of impacts if such a population(s) should be found.

5.2.8.2 Wildlife

The area of influence assessed for special status wildlife includes the area described in section 5.1.2, southeastern Sweetwater County and southwestern Carbon County. As detailed in that section, several large oil and gas development projects are occurring within the area, and others are expected. None of the projects, other than Atlantic Rim, predict significant effects upon wildlife individually or cumulatively. Atlantic Rim predicts significant effects upon big game, greater sage-grouse, and sagebrush obligates.

The combination of the individual projects is resulting in a large area of increased fragmentation, disturbance of wildlife and their habitats, and the loss of refuge areas. Additional effects are expected upon wildlife dispersal, the reduction of non-fragmented habitats, competition with livestock, and inter- and intra-specific competition with other wildlife species. The generalized increase of human presence and associated disturbance across such a broad scale are a concern. It can also be expected that competition for forage will increase in the remaining ranges leading to reduced carrying capacity and juvenile survival. Mitigations, COAs, and other BMPs will reduce the impacts of these developments, but not eliminate them. Reduced populations and population viability can be expected.

5.2.8.3 Fish

Cumulative impacts to fish species include the effects of the Atlantic Rim project and those found upstream in Muddy Creek from the ARPA. Of primary concern would be water depletions resulting in changed water conditions including salinity, volume, and temperature. At this time there are no known additional proposals to analyze or assess.

Sensitive fish, described in section 4.8, would be significantly impacted by the project. Impoundments downstream of the ARPA may be blocking sensitive fish movement into Muddy Creek, but are not attributable to the ARPA. As detailed in chapter 4, additional impoundments and alterations to natural flow characteristics (such as crossings) within Muddy Creek could have serious additional impacts to fish populations. Alteration of hydrology from roads, culverts, and other disturbances that result in re-channeling of overland flows into new channels or increasing the intensity/volume of flows within existing channels can affect sensitive fish. Blockage of fish migration within the ARPA from channel crossings would seriously impact the viability of fish populations if it should occur.

Under Alternative C, development protection measures would be applied to the Muddy Creek SMA and would effectively protect these fish populations within the ARPA.

5.2.9 Recreation Resources

The CIA area for recreation resources includes the ARPA plus parts of southwestern Carbon County and southeastern Sweetwater County that generally lie in the area bounded by Rawlins, Creston Junction, Savery, and Baggs, Wyoming. Existing mineral activities in this area include historical, ongoing, proposed, and reasonably foreseeable future oil and gas development.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Cumulative impacts to hunting, the main recreation activity in the CIA, would occur because of the extensive impacts of natural gas development on wildlife. The increased road density, traffic, noise, and dust of development displace big game species (See section 5.2.7). When big game species leave an area, hunters soon leave as well, because hunting success declines. Wildlife and hunters have already been displaced by existing development in portions of the CIA. Displacement of game and hunters would occur in areas as they are developed. As development spreads, so does displacement. This could have a serious financial effect on commercial big game outfitters that rely on wildlife and knowledge of the CIA for successful hunts. It would also tend to concentrate game and hunters in undeveloped adjacent areas, which would impact the quality and quantity of forage, and therefore the health of the animals. There would also be an increase in the probability of hunting accidents due to increased hunter density in these adjacent undeveloped areas.

Relatively undisturbed scenery is an integral part of the recreation experience for many recreationists. The visual impacts of development would make the area increasingly undesirable for many hunters as development progresses. Activities such as wildlife viewing and mountain biking also tend to be scenery-dependent. Thus incremental increases in development have corresponding decreases in the desirability of the recreational setting.

Cumulative impacts would be greatest during the development phase in the ARPA, with its associated drill rigs, vehicles, human presence, noise, and dust. Even after field development and interim reclamation are completed, the day to day maintenance of production operations would continue to displace much of the wildlife with noise, traffic, dust, and habitat fragmentation (section 3.7). The area would still be undesirable for non-consumptive visitors such as sightseers, wildlife viewers, and mountain bikers because of the poor scenery cluttered with facilities and their associated network of roads. These visitors would be forced to travel elsewhere to find natural-appearing landscapes with the aesthetics they desire.

The re-establishment of mature vegetation after final reclamation would take 30 years in some parts of the ARPA. Localized areas may not successfully revegetate for much longer. The life of the project may be up to 50 years, so the ARPA is not likely to return to its predisturbance wildlife habitat conditions for 70–80 years. Long-term cumulative impacts in the CIA would be likely to affect at least two generations by making the area less desirable for hunters, wildlife viewers, and other recreationists.

5.2.10 Visual Resources

The CIA area for visual resources includes the ARPA and parts of southwestern Carbon County and southeastern Sweetwater County that generally lie within the area bounded by Rawlins, Creston Junction, Savery, and Baggs, Wyoming. Existing mineral activities in this area include historic, ongoing, proposed, and reasonably foreseeable future oil and gas development.

The action alternatives would increase the amount of visual resources in the CIA affected by historical, ongoing, and reasonably foreseeable oil and gas development. Sixty-eight percent of the ARPA is visible from the interstate, state, county, or BLM roads, so development of the ARPA would have a high visual impact on the CIA (section 4.10). Incremental increases in development have corresponding decreases in the quality of visual resources in proximity to the development.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Cumulative impacts would be significant because development in the CIA would exceed VRM Class III management objectives by dominating the view of the casual observer. The establishment of mature vegetation after final reclamation would take 30 years in some parts of the CIA. Localized areas may not successfully revegetate for much longer. The life of the project may be up to 50 years, so the CIA is not likely to return to its predisturbance character for up to 80 years.

5.2.11 Cultural Resources

The CIA area for cultural resources is the project area and adjacent areas in southeastern Sweetwater County and southwestern Carbon County (map M-45). Table 5-3 summarizes contributing and non-contributing trail segments within the CIA, and contributing segments (only) within the ARPA. In examining the CIA, which incorporates previous EIS areas west of the ARPA within the BLM RFO boundary, approximately 130 total miles of historic trails (Overland, Cherokee and Rawlins-Baggs Road) have been subjected to potential impacts from gas development. The ARPA includes approximately 47 miles of contributing historic trail segments.

Table 5-3. Cumulative Impacts to Historic Trails

Trails Eligible for the NRHP	Total Acres (Miles) of Trails in CIA*	Total Acres (Miles) of Contributing Trails in ARPA*
Cherokee Trail	15,360 (48)	3,840 (12)**
Overland Trail	11,520 (36)	3,520 (11)
Rawlins-Baggs Road	14,720 (46)	7,680 (24)
Total	41,600 (130)	15,040 (47)

Note:

*Calculations based on ¼ mile buffer either side of trails (i.e. ½ mile corridor) or 320 acres per trail mile.

** 100% of the Cherokee Trail is considered contributing to the trail eligibility pending receipt and acceptance of the historic trail study report.

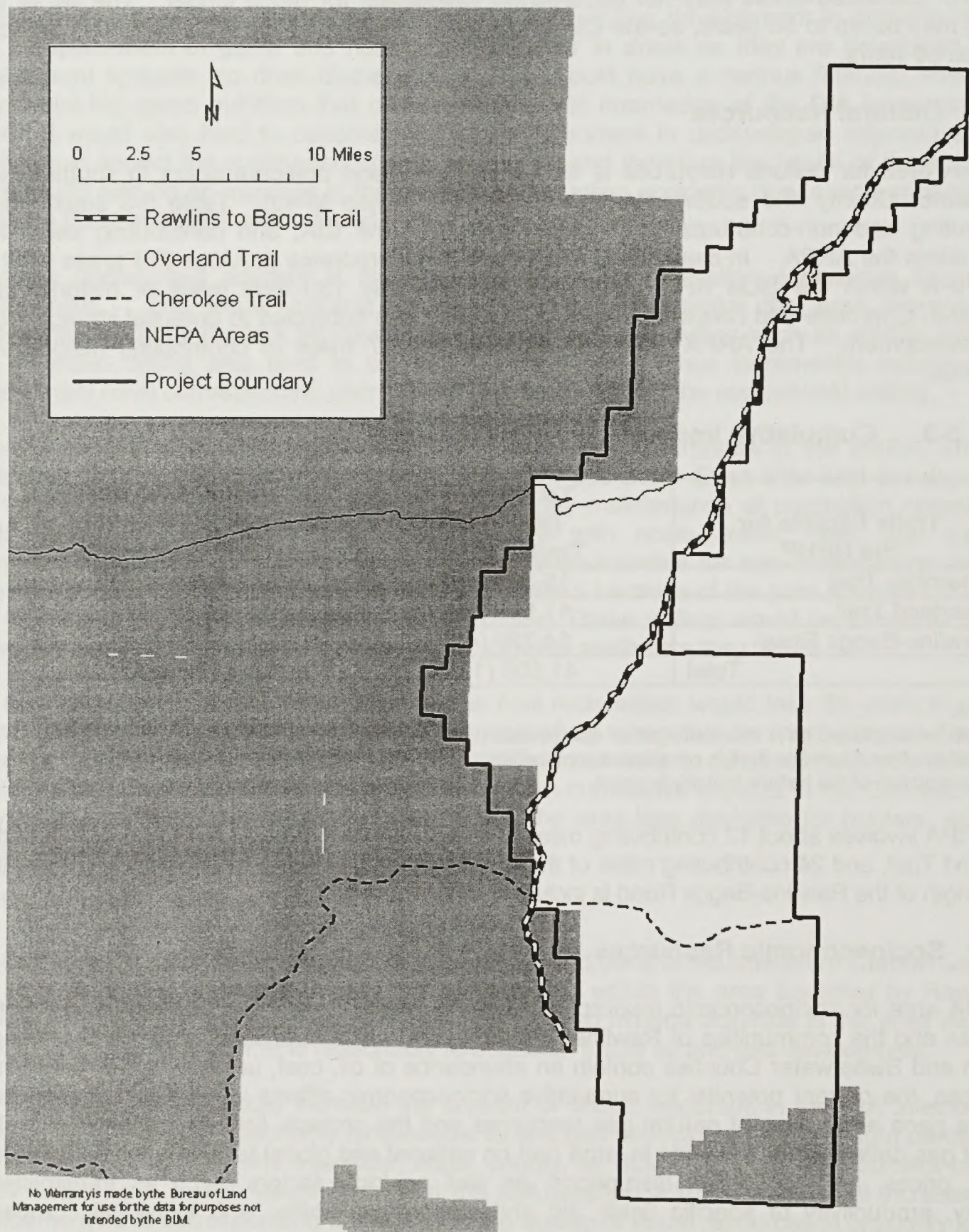
The ARPA involves about 12 contributing miles of the Cherokee Trail, 11 contributing miles of the Overland Trail, and 24 contributing miles of the Rawlins-Baggs Road. All but about 7 miles of the total length of the Rawlins-Baggs Road is included within the ARPA.

5.2.12 Socioeconomic Resources

The CIA area for socioeconomic resources includes western Carbon and eastern Sweetwater Counties and the communities of Rawlins, Baggs, Dixon, and Wamsutter, Wyoming. Although Carbon and Sweetwater Counties contain an abundance of oil, coal, uranium, trona, and other resources, the current potential for cumulative socioeconomic effects in the CIA is associated with the pace and timing of natural gas resources and the projects listed in section 5.1. The pace of gas development depends in large part on national and global factors, such as demand, supply, prices, and production disruptions, as well as local factors, such as transmission capacity, productivity of specific fields, rig and worker availability, and individual company development strategies.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Map M-45. Cumulative Impacts Historic Trails.



CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

One of the key findings of a 2003 National Petroleum Council energy policy study was that “There has been a fundamental shift in the natural gas supply/demand balance that has resulted in higher prices and volatility in recent years. This situation is expected to continue, but can be moderated” (NPC 2003).

As a result of this volatility, predicting the pace of natural gas development in the CIA is difficult to do with certainty. The U.S. Department of Energy’s Energy Information Administration prepares an Annual Energy Outlook that forecasts supply, demand, and prices for a variety of energy commodities, as well as analyzes the underlying trends for these forecasts. The 2005 Annual Energy Outlook includes forecasts for natural gas. The national average wellhead prices increase from the 2004 level of \$4.98/MCF to \$5.30/MCF in 2005, and fall to \$3.64/MCF by 2010 (all estimates in 2003). The January 2005 CREG Wyoming State Government Revenue Forecast assumed that Wyoming natural gas average annual prices would fall from the 2004 level of \$5.05/MCF to \$4.75/MCF in 2005 and to \$4.25/MCF beyond 2005. During late fall and early summer of 2005, however, increased global demand and the effects of hurricanes Katrina and Rita drove natural gas prices at Wyoming hubs above \$10/MCF. As a result, in October 2005 CREG issued new gas price forecasts of \$7.00/MCF for 2005 and \$6.00/MCF for 2006 and beyond.

Based on anticipated gas demand and resultant high prices, the pace of drilling and field development in western Carbon County and eastern Sweetwater County is likely to increase. Local governments within the Atlantic Rim study area have experienced previous energy booms and some state and local officials believe that southwestern Wyoming is on the leading edge of another sustained energy boom (Rawlins Daily Times 2006). In anticipation of that possibility, the State of Wyoming and Carbon County have mechanisms in place to assess the capabilities of community infrastructure, services, and housing and to fund and develop needed facilities. Carbon County has initiated a Community Impact Forum to examine impact issues and explore solutions.

At the state level, the 2006 Wyoming legislature funded a \$105 million energy impact assistance grant program for communities experiencing energy impacts. In June 2006, the Carbon County Commissioners approved \$19.5 million in requests for energy impact assistance funds to improve public facilities.

The rate of employment and population increase in the study area, at least in the near term, is likely to be constrained by the availability of drilling rigs and qualified workers. However, sustained high gas prices would encourage construction of new rigs and attract workers to the drilling and field development trades. The time required for buildup of drilling and field development activity would provide an opportunity for development of housing resources and expansion of local government services. The overall increase in production-related tax revenues both at the state and local levels would also provide resources to expand local government services.

Two interstate pipelines are being constructed through western Carbon County and eastern Sweetwater County; one is scheduled to be completed before the activity associated with the Atlantic Rim project would begin, but a portion of the compressor station construction phase for the Entrega pipeline may coincide with initiation of drilling and field development for the Atlantic Rim project. Completion of these pipelines could provide transportation to additional markets for locally produced gas and possibly further accelerate the pace of development.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

Assuming continued increases in drilling and field development activities over the next several years, potential cumulative impacts on area socioeconomic conditions would include:

- Positive effects on local economic conditions;
- Increased employment opportunities associated with the Atlantic Rim project and the projects listed in section 5.1;
- Increased demand for temporary and long-term housing resources and community services from in-migrating employees associated with the projects; and
- Increased federal, state, and local tax and royalty revenues generated from gas development and production.

The increased employment opportunities in the relatively higher paying energy industry would result in competition for workers to the detriment of existing businesses and government who could lose existing employees and experience difficulty in recruiting new employees. On the other hand, workers would benefit from the increased wages that would result from this competition.

Increased demand for housing and local government services from cumulative natural gas development would impact affected communities differently. Both temporary and longer-term housing demand from substantial overall increases in drilling activity would likely exceed current housing resources in all communities in the assessment area during drilling and field development seasons. In Rawlins, vacant spaces in mobile home parks and available motel rooms could be absorbed although some currently dormant motels might be reopened, which would provide additional resources. In communities in the Little Snake River Valley and in Wamsutter, temporary housing resources are typically full during the annual drilling and field development seasons, although there is some turnover from time to time. Cumulative increases in demand for temporary housing resources would likely exceed current availability in these communities on a seasonal basis.

Deficits in temporary housing resources could be mitigated by the development of drilling and construction camps. One 80-person drilling camp with capacity to expand to 150 persons has been developed along WY 789 north of Dad. Also, BP intends to develop a 400-person housing facility near Wamsutter. There are preliminary plans to develop other drilling camps in the area and to expand a mobile home/RV park in Wamsutter.

The pace of construction of new housing units in Rawlins, the Little Snake River Valley, and Wamsutter would need to increase substantially over current levels to accommodate cumulative demand for longer-term housing units. However, the development of substantial numbers of rig camp or construction camp units could free up spaces in mobile home parks, providing a resource for longer-term demand until the conventional housing market is able to respond.

Demands on most public facilities and services would be seasonal. Given the excess capacity in critical public facilities (water and sewer) in most communities, demands would be within capacity constraints. Because a large percentage of the workforce would be temporary, school enrollment would not be anticipated to increase substantially and could likely be accommodated with the existing capacity of area schools, although Rawlins might need to add modular units at the elementary school until the new school is completed. Community services, such as law

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

enforcement, emergency response, social services and road and bridge departments, are all currently experiencing increased development-related demand for services. These services would experience even higher demand, particularly during drilling and field development seasons. However, given the levels of drilling that have occurred in recent years, county general funds and services funded by special district mill levies should see substantial increase in natural gas production-related revenues. These revenues could be used to offset the costs of increases in service. In contrast, municipalities would receive few direct revenues from natural gas development and would likely face challenges in funding needed service increases to meet cumulative demand.

Cumulative development within the CIA also holds potential to affect local attitudes, opinions, and lifestyles, which are likely to be mixed. Natural gas development in Carbon and Sweetwater Counties would result in economic growth and increased employment opportunities in relatively high-paying jobs. Therefore the financial status of many residents of these counties is likely to improve, which would correspondingly increase support for cumulative development activities. On the other hand, those residents whose economic activities or recreation activities occupy the same areas as natural gas activities, such as ranchers, grazing operators, outfitters, hunters, and other recreationists, are among those most likely to be dissatisfied. Moreover, if area residents perceive that wildlife habitat and other resources are being degraded by gas development, levels of dissatisfaction could become greater and more widespread.

Although state officials are predicting a sustained energy boom (Rawlins Daily Times 2006), it is possible that energy prices could fall dramatically resulting in sudden “bust” conditions. Businesses that have expanded or been developed to accommodate drilling and field development activities would suffer economic shock under a rapid bust situation. As a consequence, communities would likely experience some out-migration of population. In the near term, a bust would be moderated by the fact that much of the drilling and field development workforce relocates to the study area in single status and stays in rig camps or construction camps. Consequently, communities near the study area would be unlikely to have substantial unoccupied conventional housing if a slowdown in drilling were to occur. Similarly, the use of energy impact assistance grants to finance needed community infrastructure should help communities avoid substantial debt that would be difficult to service under a bust scenario.

As with the Atlantic Rim project, drilling forecasts for the socioeconomic CIA typically average 10 to 20 years. Annual drilling rates are likely to be high in the early years for most fields, tapering off as drilling is completed. This forecasted gradual reduction in drilling activity should help avoid a sudden bust as these fields transition from drilling/field development to production, which has substantially lower employment requirements. As gas production gradually diminishes, production employment will correspondingly diminish. However, this gradual reduction in production employment is currently anticipated to occur over a 30- to 50-year period, which should help avoid a precipitous post-gas-development bust.

It is possible that substantial shortages of natural gas could result in accelerated rates of drilling beyond those contemplated in this assessment, with resultant energy boom-related socioeconomic impacts greater than those described above. However, such circumstances would apply to gas-producing regions throughout the country, and the lead time required to build rigs and train drilling and field development workers should correspondingly allow time for communities, companies, and state and federal governments to plan for the boom.

CHAPTER 5. CUMULATIVE IMPACTS ANALYSIS

5.2.13 Transportation

The CIA for transportation includes the ARPA and the county, state, and federal road that provide access to the site. This area is the same as that analyzed in section 4.13; therefore, cumulative impacts are the same as summarized in section 4.13.

5.2.14 Health and Safety

The area of analysis for potential cumulative impacts to health and safety is the ARPA. The Proposed Action and other action alternatives are the only RFFAs anticipated for the project area other than the existing grazing and recreation activities. Therefore cumulative impacts to health and safety conditions are anticipated to be similar to those described for the direct and indirect impacts of the Proposed Action or other action alternatives in section 4.14.

5.2.15 Noise

The area for potential cumulative noise impacts is the ARPA. Existing sound disturbances within the ARPA are limited to those associated with grazing activities, dispersed recreation, aircraft flights, and traffic on area roads and highways. The Proposed Action and other action alternatives are the only RFFAs anticipated for the ARPA that would create additional sound disturbance. Therefore, cumulative noise impacts would be similar to those associated with the Proposed Action and other action alternatives in section 4.15.

Chapter 6

Consultation and Coordination

6 Consultation and Coordination

An EIS must be prepared when a federal government agency considers approving an action within its jurisdiction that may impact the human environment. An EIS aids federal officials in making decisions by presenting information on the physical, biological, and social environment of a proposed project and its alternatives. The first step in preparing an EIS is to determine the scope of the project, the range of action alternatives, and the impacts to be included in the document.

The Council on Environmental Quality regulations (40 CFR Parts 1500–1508) require an early scoping process to determine the issues related to the proposed action and alternatives that the EIS should address. The purpose of the scoping process is to identify important issues, concerns, and potential impacts that require analysis in the EIS and to eliminate insignificant issues and alternatives from detailed analysis.

This EIS was prepared by the BLM RFO in Rawlins, Wyoming. A third-party contractor was used by the BLM to conduct studies, gather data, and prepare documents. Cooperating agencies for the Atlantic Rim project include the State of Wyoming, LSRCD, and the Saratoga Encampment Rawlins Conservation District. These agencies were actively involved in preparing, reviewing, and creating the draft and final EISs, as well as in developing mitigations and BMPs to reduce impacts from the proposed project.

6.1 Public Participation

A scoping notice was prepared and submitted to the public by the BLM on June 26, 2001, requesting comments to the proposed Atlantic Rim Natural Gas Field Development project. Scoping documents were sent out to the public listed on the BLM mailing list, as well as organizations, groups, and individuals requesting a copy of the scoping document. Public meetings to discuss the proposed project were conducted on July 10, 2001 in Baggs, Wyoming, and on July 11, 2001 in Rawlins, Wyoming. Fifty-seven written responses were received during the scoping period in response to this project. The issues and concerns identified by the public during the scoping period are summarized in chapter 1, table 1-6.

The Draft Atlantic Rim EIS was released in December 2006. The 60-day comment period resulted in over 59,400 individual comments including approximately 59,100 emails and 300 hardcopy comments. Comments were received from state, federal, and local agencies; environmental advocacy groups; landowners; leaseholders; oil and gas companies; and the public at large. Comments received were reviewed and substantive comments responded to. Response to comments are located in appendices N and O. Comments were used to develop another alternative and to modify, clarify, and correct the Final EIS as appropriate.

During preparation of the EIS, the BLM and the consultant IDT have communicated with, and received or solicited input from, cooperating agencies; other federal, state, county, and local agencies; elected representatives; environmental and citizens groups; industries; and individuals potentially concerned with issues regarding the proposed drilling action. The contacts made are summarized in the following sections.

The following organizations/individuals either provided comment or were provided the opportunity to comment during the scoping period.

CHAPTER 6. CONSULTATION AND COORDINATION

FEDERAL OFFICES

U.S. Bureau of Land Management, Wyoming State Office
U.S. Senator Mike Enzi
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency

U.S. Congresswoman Barbara Cubin
U.S. Senator Craig Thomas
U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service

STATE AGENCIES

Governor Dave Freudenthal
Governor Jim Geringer
State Engineer's Office
State Senators
Wyoming Department of Environmental
Quality

Governor's Planning Office
Wyoming Game and Fish Department
State Representatives
Wyoming State Planning Coordinator
Wyoming Department of Transportation
Wyoming Oil and Gas Conservation
Commission

COUNTY GOVERNMENT

Carbon County Commissioners

Carbon County Planning Commission

MUNICIPALITIES

Mayor-Baggs
Mayor-Rawlins

Mayor-Wamsutter

NATIVE AMERICAN TRIBES

Northern Arapahoe Tribal Council
Ute Mountain Tribe
Shoshone-Arapahoe Joint Tribal Council

Shoshone Tribal Council
Ute Tribal Council
Uinta-Ouray Tribal Council

GRAZING PERMITTEES

Weber Ranch
Salisbury Livestock Company
Three Forks Ranch Corporation
Mike Sheehan
H.B. Lee
Espy Livestock
PH Livestock Company

Montgomery Livestock Company
Stratton Sheep Company
Sam Morgan
Robert Orchard
Matt Weber
Jack Creek Land and Cattle Company

LEASE AND ROW HOLDERS

Stone & Wolf, LLC
Merit Energy Company
Benson-Montin-Greer

North Finn, LLC
P&M Petroleum Management
KCS Mountain Resources, Inc.

LANDOWNERS

The scoping notice was sent to 111 landowners potentially affected by the proposal.

CHAPTER 6. CONSULTATION AND COORDINATION

LOCAL MEDIA

Casper Star-Tribune
Rock Springs Rocket Miner
Wyoming State Tribune/Eagle
KRAI - Craig, Colorado
KRKK - Rock Springs
KTWO - Casper
KUWR - University of Wyoming

Rawlins Daily Times
Wyoming State Journal
Gillette News-Record
KRAL - Rawlins
KSIT - Rock Springs
KTWO TV - Casper
Northwest Colorado Daily News

OTHER AGENCIES, INDUSTRY REPRESENTATIVES, INDIVIDUALS, AND ORGANIZATIONS

Audubon Society
Wilderness Society
The Nature Conservancy
Field Museum of Natural History
Department of Geology
Montana Oil Journal
Murie Audubon Society
Petroleum Association of Wyoming
Sierra Club
Wyoming Outdoor Council
Wyoming Stockgrowers Association
Wyoming Woolgrowers Association
Ivan Herold
Saratoga-Encampment-Rawlins Conservation District

National Wildlife Federation
Carbon County Stockgrowers
Wyoming Association of Professional Archaeologists
Independent Petroleum Association of Mountain States
The Nature Conservancy
Rocky Mountain Oil & Gas Association
Wyoming Farm Bureau Federation
Wyoming Public Lands Council
Wyoming Wildlife Federation
Vern Brodsho
Little Snake River Conservation District
Oregon-California Trails Association

6.2 List of Preparers

The following tables identify the BLM IDT (table 6-1) and the consultant IDT (table 6-2) that were principally involved with preparing this EIS.

Table 6-1. List of BLM Interdisciplinary Reviewers.

Name	Responsibility
Rawlins Field Office	
Missy Cook	Administrative Processes Specialist / Coordinator
Susan Foley	Soil Scientist
Nina Trapp	Cultural Resources
David Simons	Team Lead/NEPA Coordinator
Andy Warren	Range Resources
Bob Hartman Jon Dull	Petroleum Engineers
Mark Newman	Paleontology/Geology

CHAPTER 6. CONSULTATION AND COORDINATION

Table 6-1. List of BLM Interdisciplinary Reviewers.

Name	Responsibility
Rawlins Field Office	
Krystal Clair	Recreation and Visual Resources
Frank Blomquist	Wildlife/Fisheries and Special Status Species
Janelle Wrigley	Realty/Lands
Robert Lange	Hydrologist
Michael Bower Patrick Lionberger	Fisheries Biologist
John Ahlbrandt	Natural Resource Specialist
Wyoming State Office	
Susan Caplan	Air Quality
Janet Kurman	NEPA

Table 6-2. List of Consultant Interdisciplinary Team EIS Preparers.

Name	Affiliation	Responsibility
Principal Interdisciplinary Team		
Gary Holsan	Gary Holsan Environmental Planning	Interdisciplinary Team Leader, Project Manager
Mark Degner	The RETEC Group, Inc.	Assistant Project Manager
Larry Hayden-Wing	Hayden-Wing Associates	Wildlife/Fisheries, Special Status Animals and Fish
Dan Gregory	The RETEC Group, Inc.	Assistant Team Lead
Francesca Liccione	Parametrix Consulting	Assistant Team Lead
Steve Moore	Gary Holsan Environmental Planning	Assistant Team Lead
Amber Travsky	Real West Consulting	Wildlife Biology
Larry Bennett	Hayden-Wing Associates	Soils, Vegetation and Wetlands, Special Status Plants, Reclamation

CHAPTER 6. CONSULTATION AND COORDINATION

Table 6-2. List of Consultant Interdisciplinary Team EIS Preparers.

Name	Affiliation	Responsibility
Principal Interdisciplinary Team		
Ben Parkhurst	Hayden-Wing Associates	Fisheries Biologist
George Blankenship	Blankenship Consulting	Socioeconomics, Transportation, Health & Safety, Noise
Lloyd Levy	Lloyd Levy Consulting	Visual Resources and Recreation
Susan Connell Jim Zapert	TRC Environmental Corporation	Air Quality
Jana Pastor	Western Wyoming College	Cultural Resources
Gustav Winterfeld	Erathem-Vanir Geological Consultants	Geology, Paleontology, Mineral Resources
Charles Bucans	Star Valley Engineering, Inc.	Proposed Action/Coordination
Technical Support Team		
Travis Olson	Hayden-Wing Associates	Wildlife Biologist, GIS Specialist
Jeff Winstead	Hayden-Wing Associates	Cartographer, Wildlife Biologist
Elasha Fain	The RETEC Group, Inc.	Technical Editor
Amy Stice	The RETEC Group, Inc.	Document Assembly/Production

References Cited

REFERENCES CITED

- Adams, S. 2005. Landowner. Personal communication with George Blankenship, Blankenship Consulting LLC. September 13, 2005.
- Alldredge, A.W., and R.D. Deblinger 1988. *Great Divide Basin Pronghorn Study*. Conducted for Minerals Company by Colorado State University. 137pp.
- Allen, J.D. and A.S. Flecker 1993. "Biodiversity Conservation in Running Waters." *BioScience* 43:32-43.
- Anderson, H.W. 1975. "Relative Contribution of Sediment from Source Areas and Transport Processes." in *Proceedings, Sediment-Yield Workshop*. November 28-30. Oxford MS. Berkeley, California: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. pp. 66-73.
- Angermeyer, P.L., A.P. Wheeler, and A.E. Rosenberger 2004. "A Conceptual Framework for Assessing Impacts of Roads on Aquatic Biota." *Fisheries* 29(12):19-29.
- AEPC 2004. *Production AREIS Annual Projections*. Excel Spreadsheet. Anadarko E & P Company, LP. October 20, 2004.
- Archer, D. L., L. R. Kaeding, B. D. Burdick, and C. W. McAda 1985. *A Study of the Endangered Fishes of the Upper Colorado River*, Final report. Cooperative agreement 14-16-0006-82-959. Grand Junction, Colorado: U.S. Department of the Interior, Fish and Wildlife Service.
- Archibald, J. D. 1993. "The Importance of Phylogenetic Analysis for the Assessment of Species Turnover: A Case History of Paleocene Mammals in North America." *Paleobiology* 19:1-27.
- ARS 2002. *Green River Basin Visibility Study. Monitored Air Quality Data*. Fort Collins, Colorado: Air Resource Specialists.
- Ayers, R. S. and D. W. Westcot 1985. *Water Quality for Agriculture: FAO Irrigation and Drainage paper 29 Rev. 1*. Food and Agriculture Organization of the United Nations. 174 pp.
- Baxter, G. T., and M. D. Stone 1992. *Amphibians and Reptiles of Wyoming*, Bulletin No. 16, Second Edition. Cheyenne, Wyoming: Wyoming Game and Fish Department. 137pp.
- Baxter, G. T., and M. D. Stone 1995. *Fishes of Wyoming*. Wyoming Game and Fish Department. 290pp.
- Beatty, R. J. 2005. *Catostomid Spawning Migrations and Late-Summer Fish Assemblages in Lower Muddy Creek, an Intermittent Watershed in Southern Carbon County, Wyoming*. Laramie, Wyoming: M.S. Thesis, Department of Zoology and Physiology, University of Wyoming.
- Beaumont, E. A. 1979. "Depositional Environments of Fort Union Sediments (Tertiary, Northwest Colorado) and Their Relation to Coal." *American Association of Petroleum Geology Bulletin* 63:194-217.

REFERENCES CITED

- Beauvais, G. P., D. Keinath, and J. Ratner 2001. *Habitat Mapping and Field Surveys for Lynx (Lynx Canadensis) on Lands Administered by the USDI-Bureau of Land Management in Wyoming*. Laramie, Wyoming: Wyoming Natural Diversity Database. 11 pp. plus appendices.
- Beck, T.D.I. and C.E. Braun 1978. "Weights of Colorado Sage Grouse." *Condor* 80(2):241-243. Summer 1978.
- Behnke, R. J. 1992. "Native trout of western North America." *American Fisheries Society Monograph* 6. Bethesda, Maryland. 275 pp.
- Belnap, J., J.H. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge 2001. *Biological Soil Crusts: Ecology and Management*. Denver, Colorado: U.S. Department of Interior, Bureau of Land Management. Technical Reference 1730-2. 110pp.
- Bettinger, R. L. and M. A. Baumhoff 1982. "The Numic spread: Great Basin Cultures in Competition." *American Antiquity* 47(3).
- Bezzerrides, N. and K. Bestgen 2002. *Status Review of Roundtail Chub (Gila robusta), Flannelmouth Sucker (Catostomus latipinnis), and Bluehead Sucker (Catostomus discobolus) in the Colorado River Basin 2002*. Fort Collins, Colorado: Colorado State University Larval Fish Laboratory.
- Biggins, D., B. Miller, B. Oakleaf, A. Farmer, R. Crete, and A. Dood 1989. *A System for Evaluating Black-Footed Ferret Habitat: Report Prepared for the Interstate Coordinating Committee*. U.S. Department of the Interior, Fish and Wildlife Service; Wyoming Game and Fish Department; and Montana Department of Fish, Wildlife and Parks.
- Binns, N. A. 1977. "Present Status of Indigenous Populations of Cutthroat Trout, *Salmo clarki*, in Southwestern Wyoming." *Fisheries Technical Bulletin No. 2*. Cheyenne, Wyoming: Wyoming Game and Fish Department. 58 pp.
- Blackstone, D. L. 1963. "Unpublished mapping, 1:250,00 scale" in *The Paleozoic History of Wyoming*, Donald W. Boyd, ed. Memoir No. 5., The Geological Survey of Wyoming, 1993. pp. 164-187.
- Blankenship PhD., T. 2002. Superintendent, Carbon County School District # 1. Personal communication with George Blankenship, Blankenship Consulting LLC. January 18, 2002.
- Blevins, A., K. Jensen, and M. Leighty 2003. "Social Assessment for the Medicine Bow National Forest Plan 15-Year Revision." Prepared for the *Final Environmental Impact Statement for the Revised Land and Resource Management Plan. Medicine Bow National Forest*. University of Wyoming, Department of Sociology. December 2003.
- Blevins, A. Ph.D. 2004. Professor of Sociology, University of Wyoming, Laramie, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. December 23, 2004.
- Blodgett, M. 2003. Director, Rawlins Workforce Center, Wyoming Department of Workforce Services, Employment and Training Division. Personal communication with George Blankenship, Blankenship Consulting LLC. October 21, 2003.

REFERENCES CITED

- Blodgett, M. 2004. Director, Rawlins Workforce Center, Wyoming Department of Workforce Services, Employment and Training Division. Personal communication with George Blankenship, Blankenship Consulting LLC. September 20, 2004.
- Bower, M.R. 2005. *Distributions and Habitat Associations of Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chubs in the Upper Muddy Creek Watershed of Southern Carbon County, Wyoming*. Laramie, Wyoming: M.S. Department of Zoology and Physiology, University of Wyoming.
- Bradley, W. H. 1964. *Geology of Green River Formation and Associated Eocene Rocks in Southwestern Wyoming and Adjacent Parts of Colorado and Utah*. U.S. Geological Survey Professional Paper 496-A, A1-A86.
- Braun, C. E. 1998. "Sage Grouse Declines in Western North America: What are the Problems?" *Proceedings of the Western Association of State Fish and Wildlife Agencies* 78:139–156.
- Braun, C. E., T. Britt, and R. O. Wallestad 1977. "Guidelines for Maintenance of Sage Grouse Habitats." *Wildlife Society Bulletin* 5:99-106.
- Breithaupt, B. H. 1982. "Paleontology and Paleoecology of the Lance Formation (Maastrichtian), East Flank Rock Springs Uplift, Sweetwater County, Wyoming." *Contributions to Geology* 21:123-151.
- Breithaupt, B. H. 1985. "Non-Mammalian Vertebrate Faunas from the Late Cretaceous of Wyoming" in *Cretaceous of Wyoming, Wyoming Geological Association 36th Annual Field Conference Guidebook*, G.E. Nelson ed. pp. 159-175.
- Busnel, M. C. and D. Molin 1978. "Preliminary Results of the Effects of Noise on Gestating Female Mice and their Pups" pp. 209-248 J. L. Fletcher and R. G. Busnel eds. *Effects of Noise on Wildlife*. New York: Academic Press.
- Call, M. W. 1974. *Habitat Requirements and Management Recommendations for Sage Grouse*. Denver, Colorado: U.S. Department of the Interior, Bureau of Land Management Technical Note. 37pp.
- Call, M. W. and C. Maser 1985. *Wildlife in Managed Rangelands – the Great Basin of Southeastern Oregon: Sage Grouse*. USDA, Forest Service General Technical Report PNW-187.
- Carbon County Board of Commissioners and Carbon County Planning Commission 1998. *Carbon County Land Use Plan*. Prepared by Pedersen Planning Consultants. Saratoga, Wyoming. Approved June.
- Carnes, S. 2002. Clerk, Town of Wamsutter. Personal communication with George Blankenship, Blankenship Consulting LLC. January 17, 2002.
- Carnes, S. 2003. Clerk, Town of Wamsutter. Personal communication with George Blankenship, Blankenship Consulting LLC. August 6, 2003.
- Carnes, S. 2005. Clerk, Town of Wamsutter. Personal communication with George Blankenship, Blankenship Consulting LLC. November 30, 2005.

REFERENCES CITED

- Carrico, G. 2005. Outfitter and rancher, Rawlins, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC.
- Carter, J.G., V.A. Lamarra, and R.J. Ryel 1986. "Drift of Larval Fishes in the Upper Colorado River." *Journal of Freshwater Ecology* 3:567-577.
- Case, G. R. 1987. "New Selachian Fauna from the Late Campanian of Wyoming (Teapot Sandstone Member, Mesaverde Formation, Big Horn Basin)." *Palaeontographica. Abteilung A: Palaeozoologie-Stratigraphie* 197(1-3):1-37.
- Case, J. C., T. V. Edgar, and R. H. DeBruin 2002. *Subsidence Potential Related to Water Withdrawal in the Powder River Basin*. Online at:
<<<http://www.wsgsweb.uwyo.edu/oilandgas/Subsidence.asp>>>
- Case, J. C., and L.L. Larsen 1991. *Landslide Map of the Rawlins 1E x 2E Quadrangle*, Open File Report 91-20, Scale 1:250,000. The Geological Survey of Wyoming
- Case, J. C., L. L. Larsen, C.S. Boyd, and J.C. Cannia 1994. *Compilers. Earthquake Epicenters and Suspected Active Faults with Surficial Expression in Wyoming*. Scale 1:1,000,000. The Geological Survey of Wyoming.
- CIRA 2003. *Interagency Monitoring of Protected Visual Environments (IMPROVE)*. Summary Data Provided by Scott Copeland, Cooperative Institute for Research in the Atmosphere (CIRA). Colorado State University. October 2003.
- City of Rawlins 1998. *Rawlins Housing Assessment, Revised 1998*. Rawlins, Wyoming. December 10, 1998.
- Clark, T. W., and M. R. Stromberg 1987. *Mammals in Wyoming*. University of Kansas Museum of Natural History, Public Education Series No. 10. 313pp.
- Clemens, W. A. 1966. "Fossil Mammals of the Type Lance Formation, Wyoming. Part II. Marsupialia." *University of California Publications in Geological Science* 62, 122pp.
- Clemens, W. A., and J.A. Lillegraven 1986. "New Late Cretaceous, North American Advanced Therian Mammals That Fit Neither the Marsupial nor Eutherian Molds" in *Vertebrates, Phylogeny, and Philosophy, Contributions to Geology*, K.M. Flanagan and J.A. Lillegraven eds. University of Wyoming, Special Paper 3. pp. 55-85.
- Clemens, W. A., J.A. Lillegraven, E.H. Lindsay, and G.G. Simpson 1979. "Where, When, and What; A Survey of Known Mesozoic Mammal Distribution" in *Mesozoic Mammals; The First Two-Thirds of Mammalian History*, J.A. Lillegraven, Z. Kielan-Jawarowska, and W.A. Clemens eds. Berkeley, California: University of California Press. pp. 7-58.
- Coates, D. A., and E.L. Heffern 1999. "Origin and Geomorphology of Clinker in the Powder River Basin, Wyoming and Montana." *Wyoming Geological Association 50th Annual Field Conference Guidebook*. pp. 211-229.
- Collentine, M., R. Libra, K. R. Feathers, and L. Hamden 1981. *Occurrence and characteristics of groundwater in the Great Divide and Washakie Basins, Wyoming*, vols. VI-A, B. Laramie, Wyoming: Water Resources Research Institute, University of Wyoming. 163 pp. plus maps.

REFERENCES CITED

- Colson, J. 2000. Sheriff, Carbon County, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. June 22, 2000.
- Colson, J. 2002. Sheriff, Carbon County, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. January 25, 2002.
- Compton, B. 2005. Personal communication with Bobby Compton. University of Wyoming.
- Crawford, J.A., R.A. Olson, N.E. West, J.C. Mosley, M.A. Schroeder, T.D. Whitson, R.F. Miller, M.A. Gregg, and C.S. Boyd 2004. "Synthesis Paper - Ecology and Management of Sage-Grouse and Sage-Grouse Habitat." *Journal of Range Management* 57(1): 2-19.
- CRBSCF 2005. *Water Quality Standards for Salinity – Colorado River System, 2005 Review*. Colorado River Basin Salinity Control Forum. July 2005.
- Creasman, S. D. and K. W. Thompson 1988. "Settlement and Subsistence of the Late Prehistoric, Uinta Phase, in the Green River Basin, Wyoming." Paper presented at the 46th Annual Plains Anthropological conference. Wichita, Kansas.
- Creasman, S. D. and K. W. Thompson 1997. "Settlement and Subsistence of the Archaic Period in the Green River Basin, Wyoming" in *Changing Perspectives on the Archaic of the Northwestern Plains*, M.L. Larson and J. E. Francis, eds. Vermillion, South Dakota: University of South Dakota Press.
- CREG 2004. *Wyoming State Government Revenue Forecast. Fiscal Year 2005 _ Fiscal Year 2010*. Wyoming Consensus Revenue Estimating Group. Online at: <<<http://eadiv.state.wy.us/CREG/CREG.asp>>> Accessed October 2004.
- Cronoble, J. M. 1969. "South Baggs C West Side Canal Gas Field, Carbon County, Wyoming, and Moffat County, Colorado," pp. 129-137 in *Guidebook to Tertiary Rocks of Wyoming. Wyoming Geological Association 21st Annual Field Conference Guidebook*, J.A. Barlow Jr. ed.
- DeBruin, R. H. 1993. "Overview of the Oil and Gas Geology of Wyoming," pp. 837-873 in *A Geology of Wyoming. at Wyoming Geological Survey Memoir 5*, A.W. Snoke, J.R. Steidtmann, and S. M. Roberts eds.
- DeBruin, R. H. 1996. *Oil and Gas Map of Wyoming*. Wyoming Geological Survey Map, MS-48.
- DeBruin, R. H., and C. S. Boyd 1991. *Oil and Gas Map of Wyoming*. Wyoming Geological Survey Map, 35, Scale 1:1,000,000.
- DeGraaf, R. M., V. E. Scott, R. H. Hamre, L. Ernst, and S. H. Anderson 1991. "Forest and Rangeland Birds of the United States." U.S. Department of Agriculture Forest Service. *Agriculture Handbook* 688. 625 pp.
- Dolan, L.S. and T.A. Wesche 1987. "Summary of Muddy Creek Surface Water and Sediment Transport Data 1984-1986." Report to the Wyoming Water Research Center. 56 pp. WWRC 87-28.

REFERENCES CITED

- Dorf, E. 1942. *Upper Cretaceous Floras of the Rocky Mountain Region: II Flora of the Lance Formation at its Type Locality, Niobrara County, Wyoming*. Carnegie Institute Washington, Publication 580. pp. 79-159.
- Driver, N. E., J. M. Norris, and G. Kuhn 1984. *Hydrology of Area 53, Northern Great Plains and Rocky Mountain Coal Provinces, Wyoming, Colorado, Idaho, and Utah*. WRI Open-File Report 83-765. Cheyenne, Wyoming: U.S. Geological Survey. 87 pp.
- Easterly, T., A. Wood, and T. Litchfield 1991. *Responses of Pronghorn and Mule Deer to Petroleum Development on Crucial Winter Range in the Rattlesnake Hills*. Unpublished Completion Report. 67 pp.
- Edge, W.D., and C.L. Marcum 1991. "Topography Ameliorates the Effects of Roads and Human Disturbance on Elk. pp. 132-137 in A.G. Christensen, L.J. Lyon, and T.N. Lonner, comps. *Proceedings of Elk Vulnerability – a Symposium*. Bozeman, Montana: Montana State University. 330pp.
- Edson, G. M. 1979. *Preliminary Geologic Map and Coal Sections of the Seaverson Reservoir Quadrangle, Carbon County, Wyoming*. U.S. Geological Survey Open-File Repository, pp. 79-1577.
- EIA 2001. *Annual Energy Outlook 2001 with Projections to 2020*. Energy Information Agency. Online at: <<www.eia.doe.gov/oiaf/aeo/>> December 2001.
- Englehart, J. 2000. Highland Enterprises. Personal communication with George Blankenship, Blankenship Consulting LLC. December 5, 2000.
- Englehart, J. 2002. Highland Enterprises. Personal communication with George Blankenship, Blankenship Consulting LLC. January 18, 2002.
- EPA 1997. *National Air Toxics Information Clearinghouse (NATICH) Database*. Research Triangle Park, North Carolina: Environmental Protection Agency, Office of Air Quality Planning and Standards.
- EPA 2002. Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States, Draft. United States Environmental Protection Agency. Washington, D.C. 2002. Online at: <<<http://epa.gov/wed/ecoregions/us/useco.doc>>>
- Erwin, R. M. 1983. "Feeding Habitats of Nesting Wading Birds: Spatial Use and Social Influences." *Auk* 100: 960-970.
- Estes, R. 1964. "Fossil Vertebrates from the Late Cretaceous Lance Formation, Eastern Wyoming." *California University Publications in Geological Sciences* 49, 180 pp.
- Evans, B. 2002. Foreman, Carbon County Road and Bridge Department, Rawlins, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. January 23, 2002.

REFERENCES CITED

- Fanning, E.J. 1986. "Wyoming's Approach to Nonpoint Pollution Control" in *Proceedings of Wyoming Water 1986 and Streamside Zone Conference – Wyoming's Water Doesn't Wait While We Debate*, April 28-30, 1986, Casper, Wyoming. Sponsored by the Wyoming Water Research Center and UW Agriculture Extension Service, University of Wyoming. pp. 63-69. *WWRC 86-05n*.
- Faure, G. 1986. *Isotope Geology*. 2nd ed. John Wiley & Sons. 589pp.
- FLAG 2000. *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report*. U.S. Forest Service-Air Quality Program, National Park Service-Air Resources Division, U.S. Fish and Wildlife Service-Air Quality Branch. December 2000.
- Fertig, W. 2000. *Status Review of the Ute Ladies'-tresses in Wyoming*. Report prepared for the Wyoming Cooperative Fish and Wildlife Research Unit, US Fish and Wildlife Service, and Wyoming Game and Fish Department by the Wyoming Natural Diversity Database. Laramie, Wyoming.
- Fertig, W. 2001. *2000 Survey for Blowout Penstemon (Penstemon haydenii) in Wyoming*. A report prepared for the Bureau of Land Management Wyoming State Office. Laramie, Wyoming: Wyoming Natural Diversity Database. University of Wyoming.
- Fertig, W. and W.A. Reiners 2002. "Predicting Presence/Absence of Plant Species for Rangemapping: a Case Study from Wyoming." In: *Predicting Species Occurrences: Issues of Scale and Accuracy*, Scott, J.M., P.J. Heglund, M. Morrison, M. Raphael, J. Haufler, B. Wall, editors. Covello, California: Island Press. 483-489.
- Fletcher, P. K., D. E. Fletcher, and L. Whitley 1999. *Cherokee Trail Diaries*. Caldwell, Idaho: Caxton Printers, Ltd.
- Fowden, M. 2005. Personal communication with Mark Fowden of the Wyoming Game and Fish Department.
- Fox, D., A.M. Bartuska, J.G. Byrne, E. Cowling, R. Fisher, G. E. Likens, S. E. Lindberg, R.A. Linthurst, J. Messer, and D.S. Nichols 1989. *A Screening Procedure to Evaluate Air Pollution Effects on Class I Wilderness Areas*. General Technical Report RM-168. Fort Collins, Colorado: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 36 pp.
- Freethy, G. W. 1987. "Upper Colorado River Basin Regional Aquifer Systems Analysis-Mesozoic rock in Colorado, Utah, Wyoming, Arizona, and New Mexico." pp. 57-70, in *Regional Aquifer Systems of the United States: Aquifers of the Western Mountain Area*, J.S. McLean and A. I. Johnson, eds. American Water Resources Association Monograph Series No. 14. 23rd Annual AWRA Conference and Symposium, Nov. 1-6, 1987. Salt Lake City, Utah. 229pp.
- Freeze, R. A., and J.A. Cherry 1979. *Groundwater*. New Jersey: Prentice-Hall, Inc. 604pp.
- Gardner, A. D., D. Allen and M. Allen 1993. *The Washakie Stage Station and Surrounding Environment 1849-1860*. Prepared for the Rawlins District, Bureau of Land Management. Rock Springs, Wyoming: Archaeological Services of Western Wyoming College.

REFERENCES CITED

- Gardner, D., D. Allen and Johnson, D. 1999. *1999 Historical Assessment of the Cherokee Trail and Bryan to Browns Park Road in Sweetwater County*. Report submitted to the Bureau of Land Management, Rock Springs Field Office. Rock Springs, Wyoming.
- Gibson, R.J., R.L. Haedrich, and C.M. Wernerheim 2005. "Loss of Fish Habitat as a Consequence of Inappropriately Constructed Stream Crossings." *Fisheries* 30(1):10-17.
- Giesen, K. M. and J. W. Connelly 1993. "Guidelines for Management of Columbian Sharp-tailed Grouse Habitats." *Wildlife Society Bulletin* 21:325-333.
- Gill, J. R., E.A. Merewether, and W. A. Cobban 1970. *Stratigraphy and Nomenclature of Some Upper Cretaceous and Lower Tertiary Rocks in South-Central Wyoming*. U.S. Geological Survey Professional Paper 667. 53pp.
- Goertler, C. M. 1992. *Sediment Dynamics Within Channel and Riparian Zone Types Along a Cold-Desert Wyoming Stream*. Laramie, Wyoming: M.S. Thesis, University of Wyoming.
- Goodrich, S., D. Nelson, and N. Gale 1999. "Some Features of Wyoming Big Sagebrush Communities on Gravel Pediments of the Green River in Daggett County, Utah." pp. 159-167 in *Shrubland Ecotones*, D.E. McArthur, W. K. Otter, and D. L. Wambolt compilers. USDA Forest Service Proc. RMRS-P-11.
- Goodrick, S. 2000. *Class III Cultural Resource Inventory for the Petroleum Development Corporation Dry Cow Creek Pod*. Prepared for Holsan Environmental Planning. Rock Springs, Wyoming: Western Archaeological Services.
- Grabow, J. 2004. Carbon County Planning Director. Personal communication with George Blankenship, Blankenship Consulting LLC. August 25, 2004.
- Graf, W.L. 1978. "Fluvial Adjustments to the Spread of Tamarisk in the Colorado Plateau Region." *Geological Society of American Bulletin* 89:1491-1501.
- Gregory, R. W., and R. H. DeBruin 1991. *Oil and Gas Fields Map of the Greater Green River Basin and Overthrust Belt, Southwestern Wyoming*. Wyoming Geological Survey Map 36.
- Grieve, P. 2000. Western United Realty, Baggs, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. December 6, 2000.
- Grieve, P. 2002. Western United Realty, Baggs, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. January 17, 2002.
- Grieve, P. 2003. Western United Realty, Baggs, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. August 6, 2003.
- Gusey, W.F. 1986. *Terrestrial Wildlife and the Petroleum Industry: Interactions and Relationships. Draft Report*. Houston, Texas: Shell Oil Company.
- Hall, D. H. 1987. *Archaeological Investigations Within the Little Snake River Basin, Colorado and Wyoming*. Fort Collins, Colorado: Master's Thesis on file, submitted to the Department of Anthropology, Colorado State University.

REFERENCES CITED

- Hand M. 2004. Project Manager, High Savery Dam and Reservoir Project, Wyoming Water Development Commission. Personal communication. August 12, 2004, and August 16, 2004.
- Hansen, B.R., S.R. Grattan, and A. Fulton 1999. Agricultural Salinity and Drainage. University of California Irrigation Program. University of California, Davis. Revised 1999.
- Hansen, N. 2004. Rancher, Little Snake River Valley. Personal communication with George Blankenship, Blankenship Consulting LLC. December 7, 2004.
- Harrell, L. 1989. *The Buffalo Hump Site: Late Prehistoric Dwellings in the Great Basin, Wyoming*. Cultural Resource Management Report No. 37. Rock Springs, Wyoming: Archaeological Services of Western Wyoming College.
- Harris, R. E. 1996. *Industrial Minerals and Construction Materials Map of Wyoming*. Wyoming Geological Survey Map, MS-47.
- Harris, R. E., W. D. Hausel, and J. E. Meyer 1985. *Metallic and Industrial Minerals Map of Wyoming*. Map Series 14, Scale 1:500,000. The Geological Survey of Wyoming,
- Harris, R. E., and J. K. King 1993. "Geologic Classification and Origin of Radioactive Mineralization in Wyoming." pp. 899-916 in *A Geology of Wyoming. at Wyoming Geological Survey Memoir 5*, A.W. Snoke, J.R. Steidtmann, and S. M. Roberts eds.
- Hawkins, M. 2000. Drifter's Inn Motel, Baggs, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC, Denver, CO. June 26, 2000.
- Hayden-Wing, L. D., D. B. Costain, J. L. Hull, M. R. Jackson, and T. B. Segerstrom 1986. "Movement Patterns and Habitat Affinities of a Sage Grouse Population in Northeastern Wyoming." Pages 207-226 in *Proceedings for Issues and Tecnnology in the Management of Impacts on Western Wildlands*, R.D. Commer, T. G. Bauman, P. Davis, J. W. Monarch, J. Todd, S. Van Gytenbeek, D. Wills, and J. Woodling eds. Glenwood Springs, Colorado. February 4-6, 1985.
- Heath, R. C. 1984. *Groundwater Regions of the United States*. U.S. Geological Survey Water-Supply Paper 2242. Washington, D.C.: U.S. Government Printing Office. 78 pp.
- Hem, J. D. 1970. *Study and Interpretation of the Chemical Characteristics of Natural Water*. U.S. Geological Survey Water-Supply Paper 1473. Washington, D.C.: U.S. Government Printing Office. 363 pp.
- Herold, R. 2000. Baggs Medical Clinic. Personal communication with George Blankenship, Blankenship Consulting LLC. June 22, 2000.
- Herold, R. 2005. Town Clerk, Town of Baggs. Personal communication with George Blankenship, Blankenship Consulting LLC. September 13, 2005.
- Herold, R. 2006. Town Clerk, Town of Baggs. Personal communication with George Blankenship, Blankenship Consulting LLC. January 18, 2006.
- Hettinger, R. D., and R. Brown 1979. *Geophysical and Lithologic Logs of 1977 Coal Drilling in the Fort Union Formation, Carbon and Sweetwater Counties, Wyoming*. U.S. Geological Survey Open-File Repository 79-326: 81pp.

REFERENCES CITED

- Hettinger, R. D., J. G. Honey, and D. J. Nichols 1991. *Chart Showing Correlations of Upper Cretaceous Fox Hills Sandstone and Lance Formation, and Lower Tertiary Fort Union, Wasatch, and Green River Formations, from the Eastern Flank of the Washakie Basin to the Southeastern Part of the Great Divide Basin, Wyoming*. Investigation Map I-2151. U.S. Geological Survey Miscellaneous Investigation Series Map.
- Hettinger, R. D., and M. A. Kirschbaum 1991. *Chart Showing Correlations of Some Upper Cretaceous and Lower Tertiary Rocks, from the East Flank of the Washakie Basin to the East Flank of the Rock Springs Uplift, Wyoming*. Investigation Map, I-2152. U.S. Geological Survey Miscellaneous Investigation Series Map.
- Hewitt, H. 2001. Carbon County Planning Commission, Coldwell Banker Hewitt and Associates. Personal communication with George Blankenship, Blankenship Consulting LLC. August 23, 2001.
- Hiatt, K. 2000. Rawlins - Carbon County Chamber of Commerce. Personal communication with George Blankenship, Blankenship Consulting LLC. June 22, 2000.
- Hiatt, G. S., and D. Baker 1981. *Effects of Oil/Gas Drilling on Elk and Mule Deer Winter Distributions on Crooks Mountain, Wyoming. Final Report*. Cheyenne, Wyoming: Wyoming Game and Fish Department. 24pp.
- Hicks, L. 2003. "History and the Customs and Culture of the Little Snake River Valley." Prepared for the *Environmental Impact Statement for the Revised Land and Resource Management Plan. Medicine Bow National Forest*. Resource Coordinator, Little Snake River Conservation District. December 2003.
- Hicks, L. 2004. Resource Coordinator, Little Snake River Conservation District. Personal communication with George Blankenship, Blankenship Consulting LLC. September 21, 2004.
- Hicks, L. 2005. Resource Coordinator, Little Snake River Conservation District. Personal communication with George Blankenship, Blankenship Consulting LLC. September 08, 2005.
- Hicks, L. and A. Warren 1992. *Muddy Creek Seeking Common Ground Project*. Baggs, Wyoming: Little Snake River Conservation District.
- Hicks, L. and A. Warren 1997. "Muddy Creek Seeking Common Ground Project." In *Proceedings of Wyoming Water 1997 – What's New in the Toolbox?* April 21-23, 1997, Casper, Wyoming. Sponsored by the Wyoming Water Resource Center, University of Wyoming, pp. 12-14. WWRC 97-05d.
- Hicks, L., A. Warren and C. Hicks 1996. "Upper Muddy Creek Coordinated Resource Management." Symposium proceedings: *Sharing Common Ground on Western Rangelands*. Sparks, Nevada.
- Hightree, N.M 2002. Emergency Medical Technician, Memorial Hospital of Carbon County. Personal communication with George Blankenship, Blankenship Consulting LLC. January 25, 2002.

REFERENCES CITED

- Hingtgen, T. M., and W. R. Clark 1984. "Small Mammal Recolonization of Reclaimed Coal Surface-mined land in Wyoming." *Journal of Wildlife Management* 48:1255-1261.
- Hoefer, T., III, S. D. Creasman, D. Murcay, and J. Bozovich 1992. "The South Baxter Brush Shelter Site: an Early Shoshonean Occupation in Southwestern Wyoming." *The Wyoming Archaeologist* 36(3-4).
- Hoffman, R.W. (Technical editor) 2001. *Northwest Colorado Columbian Sharp-tailed Grouse Conservation Plan*. Fort Collins, Colorado: Northwest Colorado Columbian Sharp-tailed Grouse Work Group.
- Holloran, M. J. 2005 *Greater Sage-Grouse (Centrocercus Urophasianus) Population Response To natural Gas Field Development In Western Wyoming*. Dissertation. Laramie, Wyoming: University Of Wyoming.
- Honey, J. G. 1988. "A Mammalian Fauna from the Base of the Eocene Cathedral Bluffs Tongue of the Wasatch Formation, Cottonwood Creek Area, Southeast Washakie Basin, Wyoming" in *Geology and Paleoecology of the Cottonwood Creek Delta in the Eocene Tipton Tongue of the Green River Formation and A Mammalian Fauna from the Eocene Cathedral Bluffs Tongue of the Wasatch Formation, Southeast Washakie Basin, Wyoming*, H.W. Roehler, J. H. Hanley, and J. G. Honey. US Geological Survey Professional Paper 1669. pp. 1-14.
- Honey, J. G. 1990. *Stratigraphic Sections Showing Coal Correlations within the Lower Coal Zone of the Paleocene Fort Union Formation, Riner Quadrangle, Carbon and Sweetwater Counties, Wyoming*. U.S. Geological Survey Coal Investigation Map, C-125.
- Honey, J. G. 2003. Personal communication with Thomas M. Bown on paleontology localities within the Atlantic Rim and adjacent areas.
- Honey, J. G., and R. D. Hettinger 1989. *Stratigraphic Sections Showing Coal Correlations within the Lower Coal Zone of the Paleocene Fort Union Formation, Fillmore Ranch and Seaverson Reservoir Quadrangles, Carbon County, Wyoming*. U.S. Geological Survey Coal Investigation Map, C-127.
- Honey, J. G., and L. N. Roberts 1989. *Stratigraphic Sections Showing Coal Correlations within the Lower Part of the Fort Union Formation in the Baggs Area, Carbon County, Wyoming*. U.S. Geological Survey Coal Investigation Map, C-135.
- HSI 1981. *Water Resources Investigation of the Atlantic Rim Project Area*, prepared for Rocky Mountain Energy. Reno/Denver: Hydro-Search, Inc.
- HWA 2000a. *Black-Footed Ferret Surveys, Atlantic Rim's Dry Cow Creek Pod, Carbon County, Wyoming*. Hayden-Wing Associates.
- HWA 2000b. *Black-Footed Ferret Surveys Atlantic Rim Sun Dog POD, Carbon County, Wyoming*. Hayden-Wing Associates.
- HWA 2001a. *Black-Footed Ferret Surveys Atlantic Rim Sun Dog POD, Carbon County, Wyoming September 9-14, 2001*. Report prepared for PEDCO and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming. September 2001.

REFERENCES CITED

- HWA 2001b. *Black-Footed Ferret Survey Results on the Atlantic Rim Blue Sky POD August, 16-18, 2001*. Report prepared for PEDCO and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming. August 2001.
- HWA 2002a. *Black-Footed Ferret Survey Results on the Atlantic Rim Blue Sky POD September 18-20, 2002*. Report prepared for PEDCO and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming. September 2002.
- HWA 2002b. *Black-Footed Ferret Survey Results on the Cow Creek Seismic Project Atlantic Rim Coalbed Methane EIS Project Area July 22-24, 2002*. Report prepared for Double Eagle and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming. July 2002.
- HWA 2004. *Vegetation and Habitat Analysis of Critical Wintering Areas for Greater Sage-Grouse. Final Report*. Laramie, Wyoming: Hayden-Wing Associates. 45 pp.
- Irby, L.R., R.J. Mackie, H.I. Pac, and W.F. Kasworm 1988. "Management of Mule Deer in Relation to Oil and Gas Development in Montana's Overthrust Belt. pp. 113-121 in *Proceedings III: Issues and Technology in the Management of Impacted Wildlife*, J. Emerick et al., editors. Boulder, Colorado: Thorne Ecological Institute.
- Johnsgard, P. A. 1986. *Birds of the Rocky Mountains*. Boulder, Colorado: Colorado University Press. 504 pp.
- Jones, R.W. 1991. *Coal Map of Wyoming*. Wyoming Geological Survey Map, MS-34.
- Kaiser, W. R., A.R. Scott, D.S. Hamilton, R. Tyler, R.G. McMurry, N. Zhou, and C. M. Tremain 1994. *Geologic and Hydrologic Controls on Coalbed Methane: Sand Wash Basin, Colorado and Wyoming*. Colorado Geological Survey Resource Series 30/Bur. Econ. Geol. Repository. Investigation, No. 220.
- Kilgore, R. 2002. Community Development Director, City of Rawlins. Personal communication with George Blankenship, Blankenship Consulting LLC. January 9, 2002.
- Kilgore, R. 2004. City of Rawlins Planning Director. Personal communication with George Blankenship, Blankenship Consulting LLC. September 25, 2004
- Kilgore, R. 2005. Community Development Director, City of Rawlins. Personal communication with George Blankenship, Blankenship Consulting LLC. September 13, 2005.
- Kot, M. 2004. Sweetwater County Planning Director. Personal communication with George Blankenship, Blankenship Consulting LLC. September 20, 2004.
- Larson, L.R. and E.A. Zimmerman 1981. *Water Resources of Upper Separation Creek Basin, South-Central Wyoming*. U.S. Geological Survey Water Resources Investigations 80-85.
- Latham, M. A. 1999. *Class III Cultural Resource Inventory and Evaluation of Eleven Prehistoric Sites: Little Snake Supplemental Irrigation Water Supply Project, High Savary Dam and Reservoir Alternative, Carbon County, Wyoming*. Burns and McDonnell.
- Lillegraven, J.A. 2002. Personal communication to Gustav F. Winterfeld.

REFERENCES CITED

- Lillegraven, J. A., and M.C. McKenna 1986. "Fossil Mammals from the "Mesaverde" Formation (Late Cretaceous, Judithian) of the Bighorn and Wind River Basins, Wyoming, with Definitions of Late Cretaceous North American Land-Mammal "Ages"." *American Museum Novitates* 2840, 68 pp.
- Lowham, H. W., L.L. DeLong, K.R. Collier, and E.A. Zimmerman 1982. *Hydrology of Salt Wells Creek—a Plains Stream in Southwestern Wyoming*. U.S. Geological Survey Water-Resources Investigations 81-62.
- Lowham, H. W., L.L. DeLong, K.D. Peter, D.J. Wangsness, W.J. Head, and B.H. Ringen 1976. *A Plan for Study of Water and its Relation to Economic Development in the Green River and Great Divide Basins in Wyoming*. U.S. Geological Survey Open File Report 76-349.
- Love, J.D. 1970. *Cenozoic Geology of the Granite Mountains Area, Central Wyoming*. U.S. Geological Survey Professional Paper 495-C, 154 pp.
- Love, J. D. and A.C. Christiansen 1985. *Compilers. Geologic Map of Wyoming*. Scale 1:500,000. U.S. Geologic Survey Map.
- Love, J.D., A.C. Christiansen, and A.J. Ver Ploeg 1993. *Compilers. Stratigraphic Chart Showing Phanerozoic Nomenclature for the State of Wyoming*. The Geological Survey of Wyoming. Map Series 41.
- Lyman, R. N. and J.E. Volkmer 2001. *Pyrophoricity (Spontaneous Combustion) of Powder River Basin Coals - Considerations for Coalbed Methane Development*. Online at: <<<http://www.wsgsweb.uwyo.edu/Coal/CR01-1.pdf>>>
- MacDonald, M.G., and A.W. Harbaugh 1988. *A Modular Three-Dimensional Finite Difference Ground-Water Flow Model*. U.S. Geological Survey Techniques of Water Resources Investigations Report 88-4046. 201pp.
- Maddux, H. R., and W. G. Kepner 1988. "Spawning of bluehead sucker in Kanab Creek, Arizona (Pisces: Catostomidae)." *Southwest Naturalist* 33:364-365.
- Malm, W.C. 2000. *Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States, Report III*. Cooperative Institute for Research in the Atmosphere, Colorado State University, ISSN 0737-5352-47.
- Manning, R.E. 1986. *Studies in Outdoor Recreation: a Review and Synthesis of the Social Science Literature in Outdoor Recreation*. Corvallis, Oregon: Oregon State University Press.
- Martin, J. W. and B. A. Carlson 1998. "Sage Sparrow (*Amphispiza belli*)" in *The Birds of North America*, No. 326, A. Poole and F. Gill eds. Philadelphia, Pennsylvania: The Birds of North America, Inc.
- Martner, B. E. 1986. *Wyoming Climate Atlas*. Lincoln, Nebraska: University of Nebraska Press.
- Massey, R. 1989. *1989 Wyoming Comprehensive Historic Preservation Plan*. Report prepared for Archive Museums, and Historic Depart, Wyoming State Historic Preservation Office. Cheyenne, Wyoming.

REFERENCES CITED

- Masursky, H. 1962. *Uranium-Bearing Coal in the Eastern Part of the Red Desert Area, Great Divide Basin, Sweetwater County, Wyoming*. U.S. Geological Survey Bulletin, 1099-B.152 pp.
- Matherne, A.M. 2006. *Effects of Roads and Well Pads on Upland Erosion in the Largo Canyon Watershed, New Mexico, 2001-2002*. U.S. Geological Survey Scientific Investigations Report 2006-5039. 24 pp.
- McGrew, P.O. 1951. "Tertiary Stratigraphy and Paleontology of South Central Wyoming." *Wyoming Geological Association, Sixth Annual Field Conference Guidebook*. pp. 54-57.
- McGrew, P.O. 1976. *Class Notes on Cenozoic Stratigraphy*. Department of Geology, University of Wyoming.
- Merewether, E. A. 1971. *Geologic Map of the Wild Horse Mountain Quadrangle, Carbon County, Wyoming*. Geologic Quadrangle Map, GQ-887. U.S. Geological Survey.
- Metcalf, M. D. 1987. "Contributions to the prehistoric chronology of the Wyoming Basin" in *Perspectives on Archaeological Resources Management in the Great Plains*, A.J. Osborn and R. C. Hassler, eds. pp. 233-261. Omaha, Nebraska: I & O Publishing Company.
- Metcalf, M. D. and K. Black 1991. *Archaeological Excavations at the Yarmony Pit House Site, Eagle County, Colorado*. Denver, Colorado: Colorado Cultural Resource Series No. 31.
- Metcalf, M. D. and P. Treat 1979. "Continuity in Late Prehistoric Period Pronghorn Procurement in Southwestern Wyoming". Paper presented at the 44th Annual Meeting of the Society for American Archaeology. Vancouver, B.C.
- Middleton, M. 1992. *Salt Content of Sediments Deposited Along Degraded and Improving Riparian Areas; Muddy Creek Wyoming*. Thesis, University of Wyoming.
- Miller, M. 1997 *Hollow Victory: The White River Expedition of 1879 and the Battle of Milk Creek*. Niwot, Colorado: University Press of Colorado.
- Miller, J.F., R.H. Frederick, and R.J. Tracey 1973. "Precipitation-Frequency Atlas of the Western United States." *National Oceanic and Atmospheric Administration Atlas 2*, vol. 2. Washington: U.S. Government Printing Office.
- Minckley, W. L. and J. E. Deacon 1991. *Battle Against Extinction: Native Fish Management in the American West*. University of Arizona Press.
- Montagne, J. de la 1991. "Cenozoic History of the Saratoga Valley Area, Wyoming and Colorado." *University of Wyoming Contributions to Geology* 29:13-70.
- Montgomery, R. 2004. Rancher, Little Snake River Valley. Personal communication with George Blankenship, Blankenship Consulting LLC. December 29, 2004.
- Morris, W. J. 1954. "An Eocene Fauna from the Cathedral Bluffs Tongue of the Washakie Basin, Wyoming." *Journal of Paleontology* 28:195-203.

REFERENCES CITED

- Murcay, D. 1993. "An Assessment of the Newly Discovered Upper Powder Spring Sites: a Hunting Complex in Southwest Wyoming." *Wyoming Archaeologist* 37(1-2). Spring 1993.
- Murray, S. 2001. *The Use of Domestic Space in an Archaic Housepit: Archaeological Investigations at the High Point Site* (48CR1790). Prepared for Williams Field Services. Submitted to the Wyoming Bureau of Land Management, Rawlins Field Office. Cultural Resource Management Report no. 72. Rock Springs, Wyoming: Western Archaeological Services.
- NARCS 2000. *Muddy Creek CRM. Bureau of Land Management, Rawlins, Wyoming*. National Applied Resource Sciences Center.
- NatureServe 2003. *NatureServe Explorer: an Online Encyclopedia of Life* [web application]. Version 1.8. NatureServe. Arlington, Virginia. Online at: <<<http://www.natureserve.org/explorer>>>
- Naugle, Dr. D.E., B.L. Walker, and K. Doherty 2006. *Sage-grouse Population Response to Coal-bed Natural Gas Development in the Powder River Basin: Interim Progress Report on Region-wide Lek-count Analyses*. Wildlife Biology Program, College of Forestry and Conseration, University of Montana. May 26, 2006.
- NEIC 2003. *Internet Search of Available Earthquake Database*. National Earthquake Information Center. Online at: <<<http://neic.usgs.gov/>>>
- NEP 2001. *Report of the National Energy Policy Group,. Reliable, Affordable, and Environmentally Sound Energy for America's Future*. National Energy Policy. May 2001. Online at: <<<http://www.whitehouse.gov/energy/National-Energy-Policy.pdf>>>
- NPC 2003. *Balancing Natural Gas Policy: Fueling the Demands of a Growing Economy*. National Petroleum Council. September 2003.
- NPS 2001. *Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds. National Park Service and U.S. Fish and Wildlife Service*. National Park Service Air Resources Division. Online at: <<<http://www.aqd.nps.gov/ard/flagfree/2001>>> Accessed July 2003.
- NPS 2004. *Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds. National park Service and U.S. Fish and Wildlife Service*. National Park Service Air Resources Division. Online at: <<<http://www.aqd.nps.gov/ard/flagfree/2001>>> Accessed July 2004. 6 pp.
- Oedekoven, O.O. 1985. *Columbian Sharp-Tailed Grouse Population Distribution and Habitat Use in South Central Wyoming*. Laramie, Wyoming: M.S. Thesis, University of Wyoming. 58 pp.
- Oil and Gas Fields Symposium Committee 1957. *Wyoming Oil and Gas Fields Symposium*. Wyoming Geological Association. 579 pp.
- Oil and Gas Fields Symposium Committee 1979. *Oil and Gas Fields Greater Green River Basin, Volumes I and II*. Wyoming Geological Association. 428 pp.

REFERENCES CITED

- Oil and Gas Fields Symposium Committee, 1992. *Oil and Gas Fields Greater Green River Basin, Wyoming*. Wyoming Geological Association. 372 pp.
- Omernik, J.M. 1987. Ecoregions of the Conterminous United States, Map (scale 1:7,500,00). *Annals of the Association of American Geographers* 77(1):118-125. 1987.
- O'Toole, P. 2004. Rancher, Little Snake River Valley. Personal communication with George Blankenship, Blankenship Consulting LLC. December 7, 2004.
- PCA 1956. *PCA Soils Primer*. Portland Cement Association.
- Perry, C., and R. Overly 1976. "Impact of Roads on Big Game Distribution in Portions of the Blue Mountains of Washington." pp. 62-68 in S.R. Heib, editor. *Proceedings of the Elk-Logging Roads Symposium*. Moscow, Idaho: University of Idaho.
- Peterson, R.A. 1993. *The Erodibility of the Muddy Creek Channel*. Laramie, Wyoming: M.S. Thesis, University of Wyoming.
- PFResources 2000. *Carbon/Sweetwater Counties of Wyoming: Workforce Report*. Dallas, Texas. October 2000.
- Pipiringos, G. N. 1961. *Uranium-Bearing Coal in the Central Part of the Great Divide Basin*. U.S. Geological Survey Bulletin 1099-A. 104 pp.
- Poland, J. F. 1984. "Mechanics of Land Subsidence Due to Fluid Withdrawal" in *Guidebook to Studies of Land Subsidence Due to Ground-Water Withdrawal: Studies and Reports in Hydrology 40*, J.F. Poland ed. Prepared for the International Hydrological Programme, Working Group 8.4, United Nations Educational, Scientific, and Cultural Organization (UNESCO). Paris, France. pp. 37-54.
- Porter, M. A. 1999. *Spatial Relationships Between Sympatric Mule Deer and Elk in South-Central Wyoming*. Laramie, Wyoming: M.S. Thesis, University of Wyoming. 60 pp.
- Powell, J. 2003. *Distribution, Habitat Use Patterns, and Elk Response to Human Disturbance in the Jack Morrow Hills, Wyoming*. MS Thesis. Laramie, Wyoming: University of Wyoming.
- Quist, M.C., M.R. Bower, and W.A. Hubert In press. "Summer Food Habitat and Trophic Overlap of Round Tail Chub and Creek Chub in Muddy Creek, Wyoming" *Southwestern Naturalist*.
- Rawlins Daily Times 2000. *Rag Shoshone Coal Mine Closes Thursday*. August 30, 2000.
- Rawlins Daily Times 2001. *Wamsutter Ponders Impacts*. February 7, 2001.
- Rawlins Daily Times 2006. *State in a "New" Era with Energy and For 20 years, its About Energy, Governor Says*. April 22, 2006.
- Reeve, A. F. 1984. *Environmental Influences on Male Pronghorn Home Range and Pronghorn Behavior*. Laramie, Wyoming: PhD. Dissertation, University of Wyoming. 172 pp.

REFERENCES CITED

- Remington, T. E., and C. E. Braun 1991. "How Surface Coal Mining Affects Sage Grouse, North Park, Colorado." *Proceedings, Issues and Technology in the Management of Impacted Western Wildlife*. Thorne Ecological Institute 5:128–132.
- Rigby, J. K., Jr. 1980. "Swain Quarry of the Fort Union Formation, Middle Paleocene (Torrejonian) Carbon, County, Wyoming: Geological Setting and Mammalian Fauna." *Evolutionary Monographs* 3, 179 pp.
- Ritzma, H. R. 1949. *Geology Along the Southwest Flank of the Sierra Madre, Carbon County, Wyoming*. M.A. Thesis, University of Wyoming unpublished.
- Roehler, H. W. 1972. "A Review of Eocene Stratigraphy in the Washakie Basin, Wyoming." *Wyoming Geological Association Guidebook Field Conference on Tertiary Biostratigraphy of Southern and Western Wyoming*. pp. 3-19.
- Roehler, H. W. 1973. *Stratigraphy of the Washakie Formation in the Washakie Basin, Wyoming*. U.S. Geological Survey Bulletin 1369, 40 pp.
- Roehler, H. W. 1977. *Geologic map of the Rock Springs Uplift and Adjacent Areas, Sweetwater County, Wyoming*. U.S. Geological Survey Open File Report 77-242, Scale 1:250,000.
- Roehler, H. W. 1985. *Geologic Map of the Kinney Rim 30 x 60 Minute Quadrangle, Wyoming and Colorado*. U.S. Geological Survey Miscellaneous Investigation Series Map I-1615, Scale 1:100,000.
- Roehler, H. W. 1991a. "Revised Stratigraphic Nomenclature for the Wasatch and Green River Formations" in *Geology of the Eocene Wasatch, Green River, and Bridger (Washakie) Formations, Green River Basin, Wyoming, Utah, and Colorado*. U.S. Geological Survey Professional Paper 1506-B, 38 pp.
- Roehler, H. W. 1991b. "Godiva Rim Member- A New Stratigraphic Unit of the Green River Formation in Southwest Wyoming and Northwest Colorado" in *Geology of the Eocene Wasatch, Green River, and Bridger (Washakie) Formations, Green River Basin, Wyoming, Utah, and Colorado*. U.S. Geological Survey Professional Paper 1506-B, 38 pp.
- Roehler, H. W. 1992a. *Introduction to Greater Green River Basin Geology, Physiography, and History of Investigations*. U.S. Geological Survey Professional Paper 1506-A, 14 pp.
- Roehler, H. W. 1992b. *Description and Correlation of Eocene Rocks in Stratigraphic Reference Sections for the Green River and Washakie Basins, Southwest Wyoming*. U.S. Geological Survey Professional Paper 1506-D, 83 pp.
- Roehler, H. W. 1992c. *Correlation, Composition, Aerial Distribution and Thickness of Eocene Stratigraphic Units, Greater Green River Basin, Wyoming, Utah, and Colorado*. U.S. Geological Survey Professional Paper 1506-E, 49 pp.
- Roehler, H. W. 1993. *Eocene Climates, Depositional Environments, and Geography, Greater Green River Basin, Wyoming, Utah, and Colorado*. U.S. Geological Survey Professional Paper 1506-F, 14 pp.

REFERENCES CITED

- Roehler, H. W., J.H. Hanley, J.G. Honey 1988. *Geology and Paleoecology of the Cottonwood Creek Delta in the Eocene Tipton Tongue of the Green River Formation and A Mammalian Fauna from the Eocene Cathedral Bluffs Tongue of the Wasatch Formation, Southeast Washakie Basin, Wyoming*. U.S. Geological Survey Bulletin 1669 52 pp.
- Rosenberg, R. 1994. IMACS site form addendum for site 48CR3648.
- Rotenberry, J. T., M. A. Patten, and K. L. Preston 1999. "Brewer's Sparrow (*Spizella breweri*)" in *The birds of North America*, No. 390, A. Poole and F. Gill, eds. Philadelphia, Pennsylvania: The Birds of North America, Inc.
- Rumbaugh, J.O., and D.B. Rumbaugh 2002. *Groundwater Vistas Version 3.33, Software and User's Manual*. Environmental Simulations Inc.
- Sanders, R. B. 1974. *Geologic Map and Coal Resources of the Riner Quadrangle, Carbon and Sweetwater Counties, Wyoming*. U.S. Geological Survey Coal Investigation Map, C-68.
- Sanders, R. B. 1975. *Geologic Map and Coal Resources of the Creston Junction Quadrangle, Carbon and Sweetwater Counties, Wyoming*. U.S. Geological Survey Coal Investigation Map, C-73.
- Sawyer, H., R. Nielson, L. McDonald, and D. Strickland 2004. *2004 Annual Report. Sublette Mule Deer Study (Phase II): Long-term Monitoring Plan to Assess Potential Impacts of Energy Development on Mule Deer in the Pinedale Anticline Project Area*. Cheyenne, Wyoming: WesternEcosystems Technology, Inc.
- Scheffe, R.D. 1988. *VOC/NO_x Point Source Screening Tables*. Research Triangle Park, North Carolina: Office of Air Quality Planning and Standards. August 1988.
- Schlosser, I.J. 1995. "Critical landscape attributes that influence fish population dynamics in headwater streams." *Hydrobiologia* 303:71-81.
- Schroeder, T. 2005. Program Principal, Wyoming Department of Environmental Quality, Industrial Siting Division. Personal communication with David Simons, U.S. Department Of Interior, Bureau of Land Management, Rawlins Field Office. November 4, 2005.
- Scott, A. R., R. Tyler, D.S. Hamilton, and N. Zhou 1994. "Coal and In-Place Gas Resources of the Greater Green River Basin." *American Association of Petroleum Geologists Annual Convention Program with Abstracts* 4:253-254.
- Seaber, P.R., F.P. Kapinos, and G.L. Knapp 1987. *Hydrologic Unit Maps*. U.S. Geological Survey, Water-Supply Paper 2294.
- Shimkin, D.B. 1986 Eastern Shoshone, in W.L. D'Azevedo (Editor): *Handbook of North American Indians* Vol. 11: Great Basin, pp. 308-35. Smithsonian Institution. Washington, D.C.
- Shields, F. D., S. S. Knight, and C. M. Cooper 1994. "Effects of Channel Incision on Base Flow Stream Habitats and Fishes." *Environmental Management* 18:43- 57.

REFERENCES CITED

- Skinner, Q.D., M.A. Smith, T.A. Wesche, and S. Lowry 1989. "A Survey of Values Associated with Riparian Conditions of a Stream Tributary to the Green/Colorado River." in *Practical Approaches to Riparian Resource Management; an Educational Workshop, Billings, Montana*, R.E. Gresswell, B.A. Barton and J.L. Kershner eds. pp. 175. WWRC 89-48.
- Skinner, Q.D., M.A. Smith, T.A. Wesche, J.S. Todd and J.D. Rodgers 1991. "Research Findings from Riparian Zone Management on Muddy Creek." in *Proceedings of the Third Intermountain Meadow Symposium*, Steamboat Springs, Colorado. pp. 1-8. WWRC 91-24.
- Smith, A. M. 1974. *Ethnography of the Northern Utes*. Albuquerque, New Mexico: Museum of New Mexico Papers in Anthropology No. 17.
- Smith, J. H. 1961. "A Summary of Stratigraphy and Paleontology, Upper Colorado and Montanan Groups, South-Central Wyoming, Northeastern Utah, and Northwestern Colorado." pp. 101-112 in *Symposium on Late Cretaceous rocks, Wyoming and Adjacent Areas; Wyoming Geological Association 16th Annual Field Conference Guidebook*.
- Smith, J. B., M.F. Ayler, C.C. Knox, and B. C. Pollard 1972. *Strippable Coal Reserves of Wyoming*. U.S. Bureau of Mines Inf. Circular, IC-8538: 51 pp.
- Sullivan, R. 1980. *A Stratigraphic Evaluation of the Eocene Rocks of Southwestern Wyoming*. Geological Survey of Wyoming Report of Investigations 20, 50 pp.
- Tart, D. L. and A. H. Winward 1996. Revised 2001. "Key to sagebrushes (*Artemisia*) of Wyoming" in *Big sagebrush plant associations of the Pinedale Ranger District, Final Review Draft*. Bridger-East Ecological Unit Inventory, Bridger-Teton National Forest.
- Taylor, D. 2004. Professor/Extension Specialist, Department of Agricultural and Applied Economics. Personal communication with George Blankenship, Blankenship Consulting LLC. August 4, 2004.
- Texas Resource Consultants 1981. *Soil Inventory of the Overland Area Wyoming*. Prepared for the Bureau of Land Management in Cooperation with the Soil Conservation Service.
- Thomas, J.W., and D.E. Toweill eds. 1982. *Elk of North America: Ecology and Management*. Stackpole. 698 pp.
- Thompson, J. 2001. "Muddy Creek Coordinated Resource Management Project, Carbon County Wyoming." *Workshop on Collaborative Resource Management in the Interior West*. Red Lodge, Montana.
- Thompson, K. W. 1989. *Salvage Excavations at the Nova Site, a Late Prehistoric Housepit in South Central Wyoming*. Cultural Resource Management Report No. 49. Rock Springs, Wyoming: Archaeological Services of Western Wyoming College.
- Thompson, K. W. and J. V. Pastor 1995. *People of the Sage: 10,000 Years of Occupation in Southwest Wyoming*. Cultural Resource Management Report No. 67. Rock Springs, Wyoming: Archaeological Services of Western Wyoming College.

REFERENCES CITED

- Trewartha, G. 1968. *An Introduction to Climate*. New York, New York: McGraw-Hill Book Company. 408 pp.
- Trombulak, S.C. and C.A. Frissell 2000. "Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities." *Conservation Biology* 14:18-30.
- UDNR 2004. *Range-wide Conservation Agreement for Roundtail Chub, Gila robusta, Bluehead Sucker, Catostomus discobolus, and Flannelmouth Sucker, Catostomus latipinnis*. Salt Lake City, Utah: Utah Department of Natural Resources.
- U.S. Census Bureau 2000a. *Census 2000, Summary File 1*. Online at: <<http://ealdiv.state.wy.us/demog_data/pop2000/pop00.htm>> Accessed March 2003.
- U.S. Census Bureau 2000b. *Census 2000, Summary File 3*. Online at: <<http://ealdiv.state.wy.us/demog_data/pop2000/pop00.htm>> Accessed March 2003.
- U.S. Census Bureau 2002. *Table DP-4. Profile of Selected Housing Characteristics: 2000, Rawlins City, Wyoming*. Online at: <<<http://ealdiv.state.wy.us/demogdata/pop2000/ProfilePDFsWY/63900.pdf>>> June 4, 2002. Accessed August 2003.
- U.S. Census Bureau 2004. *Households and Household Change: 1990 – 2000*. Online at: <<http://ealdiv.state.wy.us/demog_data/pop2000/Census_Tables/Households90_00.xls>> Accessed March 2004.
- USDA 1954. *Agriculture Handbook 60*. U.S. Department of Agriculture.
- USDA-FS 1989. *A Screening Procedure to Evaluate Air Pollution Effects on Class I Wilderness Areas. General Technical Report RM-168*. Fort Collins, Colorado: U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station. 36 pp.
- USDA-FS 2000. *Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide*. U.S. Department of Agriculture Forest Service, Rocky Mountain Region. January 2000.
- USDA-SCS 1971. *Guide for Interpreting Engineering Uses of Soils*. 87 pp. Washington, D.C.: U.S. Government Printing Office.
- USDI-BLM 1980. *BLM Handbook H-8410-1 – Visual Resource Inventory*. U.S. Department of Interior, Bureau of Land Management. 1980.
- USDI-BLM 1983. *Riley Ridge EIS Air Resources Technical Report*. Kemmerer, Wyoming: U.S. Department of Interior, Bureau of Land Management, Kemmerer Field Office, in Cooperation with Environmental Research and Technology Inc.
- USDI-BLM 1987. *Muddy Creek Watershed Plan, Divide Resource Area, Rawlins, Wyoming*. U.S. Department of Interior, Bureau of Land Management.

REFERENCES CITED

- USDI-BLM 1988. *Proposed Resource Management Plan/Final Environmental Impact Statement for the Great Divide Resource Area (Formerly Medicine Bow and Divide Resource Areas) Rawlins District, Wyoming*. Rawlins, Wyoming: U.S. Department of the Interior, Bureau of Land Management, Great Divide Resource Area, Rawlins District Office. 249pp.
- USDI-BLM 1990. *Great Divide Resource Area Record of Decision and Approved Resource Management Plan*. Rawlins, Wyoming: U.S. Department of the Interior, Bureau of Land Management, Rawlins District Office, Great Divide Resource Area. 74pp.
- USDI-BLM 1994. *Creston/Blue Gap Natural Gas Project Environmental Impact Statement, Carbon and Sweetwater Counties, Wyoming, Rawlins Field Office, Rawlins, Wyoming*. U.S. Department of the Interior, Bureau of Land Management. 74pp.
- USDI-BLM 1995. *Greater Wamsutter Area II Natural Gas Development Project Environmental Impact Statement, Rawlins Field Office, WY*. U.S. Department of the Interior, Bureau of Land Management.
- USDI-BLM 1997. *Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for Public Land Administered by the Bureau of Land Management in the State of Wyoming*. Bureau of Land Management, Wyoming State Office. Cheyenne, Wyoming, pg. 13. August 12, 1997.
- USDI-BLM 1999. *Management (VRM) Manual H-8431, Visual Resource Contrast Rating*. Online at: <<http://www.blm.gov/nstc/VRM/8410.html>>> November 8, 2004.
- USDI-BLM 2000a. *Continental Divide/Wamsutter II Natural Gas Development Environmental Impact Statement and Record of Decision, Sweetwater and Carbon Counties, Wyoming, Rawlins and Rock Springs Field Offices*. U.S. Department of the Interior, Bureau of Land Management. May 2000.
- USDI-BLM 2000b. *South Baggs Area Natural Gas Development Project Environmental Impact Statement, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. August 2000.
- USDI-BLM 2001a. *Issuance of BLM (Wyoming) Sensitive Species Policy and List*. Instruction Memorandum no. WY-2001-040, from Alan R. Pierson, State Director, Cheyenne, Wyoming. April 9, 2001.
- USDI-BLM 2001b. *Environmental Assessment for the Atlantic Rim Coalbed Methane Project, Sun Dog Pod, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. September 2001.
- USDI-BLM 2002a. *BLM Wyoming sensitive species policy and list, September 20, 2002*. Bureau of Land Management, Cheyenne, Wyoming. U.S. Department of the Interior, Bureau of Land Management. 14pp.
- USDI-BLM 2002b. *Environmental Assessment for the Atlantic Rim Coalbed Methane Project, Blue Sky Pod, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. January, 2002.

REFERENCES CITED

- USDI-BLM 2002c. *Environmental Assessment for the Atlantic Rim Coalbed Methane Project, Cow Creek Pod, Carbon County, Wyoming, Rawlins, WY*. U.S. Department of the Interior, Bureau of Land Management. February 2002.
- USDI-BLM 2002d. *Technical Support Document, Air Quality Impact Assessment for the Montana Final Statewide Oil and Gas EIS and Proposed Amendment of the Powder River and Billings Resource Management Plans and the Wyoming Final EIS and Planning Amendment for the Powder River Basin Oil and Gas Development Project*. Prepared for U.S. Department of Interior, Bureau of Land Management, Montana and Wyoming State Offices, by Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.
- USDI-BLM 2002e. *Upper Colorado River Basin Standards and Guidelines Assessment*. Rawlins, Wyoming: U.S. Department of Interior, Bureau of Land Management, Rawlins Field Office.
- USDI-BLM 2002f. *Vermillion Basin Natural Gas Exploration and Development Project Environmental Assessment, Sweetwater County, Wyoming, Rock Springs Field Office*. U.S. Department of the Interior, Bureau of Land Management. August 200. Online at: <http://www.wy.blm.gov/nepa/rsfdocs/vermbasin/index.htm>
- USDI-BLM 2003a. *FEIS and ROD for Powder River Basin Oil and Gas Project (BLM/WY/PL-03/004+1310)*. U.S. Department of the Interior, Bureau of Land Management. January 2003. 20pp.
- USDI-BLM 2003b. *Rawlins Field Office, Rawlins Resource Management Plan Management Situation Analysis (MSA)*. Online at: http://www.rawlinsrmp.com/documents_MSA.html>> Accessed October 2003.
- USDI-BLM 2003c. *Wild Horse Herd Management Areas*. Rawlins Field Office, Rawlins, Wyoming, U.S. Department of the Interior, Bureau of Land Management. Online at: <http://www.blm.gov/rfo/wh.htm>>>
- USDI-BLM 2003d. *Environmental assessment for the Atlantic Rim coalbed methane project, Brown Cow POD, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. December 2003.
- USDI-BLM 2003e. *Environmental Assessment for the Atlantic Rim Interim Drilling Project, Doty Mountain POD, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. October 2003.
- USDI-BLM 2003f. *Environmental Assessment for the Atlantic Rim Interim Drilling Project, Red Rim POD, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. November 2003.
- USDI-BLM 2003g. *Desolation Flats Natural Gas Development Project Environmental Impact Statement, Sweetwater and Carbon Counties, Wyoming, Rawlins and Rock Springs Field Offices*. U.S. Department of the Interior, Bureau of Land Management.
- USDI-BLM 2004a. *Desolation Flats Natural Gas Field Development Project Environmental Impact Statement, Carbon County, Wyoming, Rawlins and Rock Springs Field Office*. U.S. Department of the Interior, Bureau of Land Management. May 2004.

REFERENCES CITED

- USDI-BLM 2004b. *Environmental Assessment for the Atlantic Rim Interim Drilling Project, Jolly Roger POD, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. September, 2004.
- USDI-BLM 2004c. *RMP DEIS 2004*. U.S. Department of the Interior, Bureau of Land Management, Rawlins Field Office .
- USDI-BLM 2004d. *Environmental Assesment for the Hay Reservoir Unit Natural Gas Infill Development Project, Carbon County, Wyoming, Rawlins Field Office*. U.S. Department of the Interior, Bureau of Land Management. October 2004. Online at: <http://www.wy.blm.gov/nepa/rfodocs/hayreservoir2/index.htm>
- USDI-BLM 2006. *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*. U.S. Department of the Interior and the United States Department of Agriculture. 2006.. BLM/WO/ST-06/021+3071. Bureau of Land Management. Denver, Colorado. 84 pp
- USDI-FWS 1985. *Recovery Plan for the Pahrnagat Roundtail Chub, Gila robusta jordani*. Portland, Oregon: U.S. Department of the Interior, Fish and Wildlife Service. U.S. Fish and Wildlife Service. 71pp.
- USDI-FWS 1989. *Black-Footed Ferret Survey Guidelines for Compliance with the Endangered Species Act*. Denver, Colorado and Albuquerque, New Mexico: U.S. Department of the Interior, Fish and Wildlife Service. 15pp.
- USDI-FWS 1993. *Colorado River Endangered Fishes Critical Habitat. Draft Biological Support Document*. Salt Lake City, Utah: U.S. Department of the Interior, Fish and Wildlife Service.
- USDI-FWS 1995. "Intra-Service Section 7 Counsultation for Elimination of Fees for Water Depletions of 100 Acre-Feet or Less from the Upper Colorado River Basin." Memorandum to the Assitant Regional Director, Ecological Services, Region 6, from Regional Director 6. March 9, 1995.
- USDI-FWS 1999. "Endangered and Threatened Wildlife and Plants: Proposed Threatened Status Mountain Plover." United States Fish and Wildlife Service. *Federal Register* 64: 7587-7601.
- USDI-FWS 2002. *Endangered, Threatened, Proposed, Petitioned and Candidate Species of Wyoming*. Cheyenne, Wyoming: U.S. Department of the Interior, Fish and Wildlife Service, Wyoming Field Office.
- USDI-FWS 2003. *Upper Colorado River Endangered Fish Recovery Program and San Juan River Basin Recovery Implementation Program, Program Highlights 2002-2003*. U.S. Fish and Wildlife Service. Online at: <http://mountainprairie.fws.gov/ColoradoRiver/publicpages/Highlights02-03.pdf>>> Accessed February 11, 2004.
- USDI-FWS 2004. *Threatened, Endangered, and Proposed Species of Carbon, County, Wyoming*. Cheyenne, Wyoming: U.S. Department of the Interior, Fish and Wildlife Service.

REFERENCES CITED

- USDL-BLS 2000. *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Selected Industries and Case Types*. Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics.
- USDOT 1998. *Hazardous Liquid and Natural Gas Pipeline Safety Data and Property Damage*. National Transportation Statistics. Washington, D.C.: U. S. Department of Transportation.
- USGS 1976. *Hydrologic Unit Map, 1974, State of Wyoming*. Reston, Virginia: U.S. Geological Survey.
- USGS 1980. *Water Resources Data for Wyoming, Water Year 1978: v. 2* USGS Water-Data Report WY-78-2. U.S. Geological Survey.
- USGS 2004. *Patuxent Wildlife Research Center*. United States Geological Survey. Online at: <<<http://www.mbr-pwrc.usgs.gov/bbs/cbcra/h3780ra.html>>>
- USGS 2005. *Streamflow and Surface Water Quality Summaries of USGS Stations Available on the Internet*. U.S. Geological Survey. Online at: <<<http://waterdata.usgs.gov/usa/nwis/>>>
- Upper Colorado River Endangered Fish Recovery Program 1999. *Website of the Upper Colorado River Endangered Fish Recovery Program*. Online at: <<<http://www.r6.fws.gov/coloradoriver>>>
- UW 1997. *Southwest Wyoming Resource Evaluation: Part 1, Historical Context, Final Report*. Prepared for the US Bureau of Land Management, Wyoming State Office. University of Wyoming, College of Agriculture, Cooperative Extension Service, Agricultural Economics Department. May 1997.
- Valdez, R. A. and G. H. Clemmer 1982. "Life History and Prospects for Recovery of the Humpback and Bonytail Chub." pages 109-119 in *Fishes of the Upper Colorado River System: Present and Future*, W.H.Miller, H.M. Tyus, and C.A. Carlson, eds. Bethesda, MD: Western Division, American Fisheries Society.
- Valdez, R. A., R. J. Ryel, S. W. Carothers, and D. A. House 2000. *Recovery Goals for the Humpback Chub (Gila cypha) of the Colorado River Basin: A supplement to the Humpback Chub Recovery Plan*. Washington, D.C.: U.S. Department of the Interior, U.S. Fish and Wildlife Service.
- Van Voast, W. A.. 2003. "Geochemical Signature of Formation Waters Associated with Coalbed Methane." *AAPG Bulletin* 87(4):667-676.
- Vosika, B. N. 2000. USDI-BLM NEPA Coordinator, Rawlins Field Office. Personal communication with George Blankenship, Blankenship Consulting LLC. May 5, 2000.
- Waldner, V. 2000. Personal communication with George Blankenship, Blankenship Consulting LLC. December 5, 2000.
- Waldner, V. 2002. Personal communication with George Blankenship, Blankenship Consulting LLC. January 18, 2002.

REFERENCES CITED

- Waldner, V. 2004. Mobile home park owner, Wamsutter, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. November 5, 2004.
- Waldner, V. 2005. Mobile home park owner, Wamsutter, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. September 13, 2005.
- Ward, A.L. 1976. "Elk Behavior in Relation to Timber Harvest Operations and Traffic on the Medicine Bow Range in South-Central Wyoming." in Hieb, S.R., ed. *Proceedings of the elk-logging-roads symposium*. Moscow, Idaho: Forestry, Wildlife and Range Experiment Station, University of Idaho: 32-43.
- Ward, A.L., J.J. Cupal, A.L. Lee, C.A. Oakley, and R.W. Weeks 1973. "Elk Behavior in Relation to Cattle Grazing, Forest Recreation, and Traffic." *Transactions of the North American Wildlife and Natural Resources Conference* 38:327-337.
- Warren, A. 2000. USDI-BLM Range Management Specialist, Rawlins Field Office. Personal communication with George Blankenship, Blankenship Consulting LLC. June 14, 2000.
- Warren, A. 2006. *Browse Monitoring/Trend Report: Lower Muddy Creek Watershed*. USDI-BLM Rawlins Field Office, Wyoming. June 19, 2006.
- Waters, T.F. 1995. *Sediment in Streams: Sources, Biological Effects and Control*. Monograph 7. Bethesda, Maryland: American Fisheries Society.
- WDAI 2001. *Division of Economic Analysis. Population for Counties and Incorporated Places: 1990 and 2000*. Wyoming Department of Administration and Information.
- WDAI 2002b. *Wyoming Incorporated Place Population Estimates: April 1, 2000 to July 1, 2002*. Wyoming Department of Administration and Information. Online at: <<<http://eadiv.state.wy.us/pop/SUB-02EST.htm>>> Accessed October 2003.
- WDAI 2003a. *Employment by Industry for the United States, Wyoming and Wyoming Counties*. Wyoming Department of Administration and Information.
- WDAI 2003b. *Regional Economic Profiles*. Wyoming Department of Administration and Information. Online at: <<<http://eadiv.state.wy.us/i&e/econ-profile.htm>>>
- WDAI 2003c. *Total Tax Collections by County*. Wyoming Department of Administration and Information. Online at: <<<http://eadiv.state.wy.us/s&UTax/s&u.asp>>>
- WDAI 2003d. *Consensus Revenue Estimating Group, Wyoming State Revenue Forecasts. Fiscal Year 2003 - Fiscal Year 2008. Table 6. Mineral Severance Taxes to all Accounts; Fiscal Year Distributions by Mineral*. Wyoming Department of Administration and Information. January 2003.
- WDAI 2004a. *Historical Decennial Census Population for Wyoming Counties, Cities, and Towns*. Online at: <<http://eadiv.state.wy.us/demog_data/cntycity_hist.htm>> Accessed October 2004.
- WDAI 2004b. *Annual population for Cities, Counties and Towns 1990 to 2000 and Wyoming Incorporated Place Population Estimates: April 1, 2000 to July 1, 2003*. Online at: <<http://eadiv.state.wy.us/pop/c&sc90_00.htm>> and <<<http://eadiv.state.wy.us/pop/SUB-03EST.htm>>> Accessed October 2004.

REFERENCES CITED

- WDAI 2004c. *Population for Wyoming, Counties, Cities, and Towns: 2000 to 2020*. Online at: <<<http://eadiv.state.wy.us/pop/wyc&sc20.htm>>> Accessed October 2004.
- WDE 2004. *Local Area Labor Force Information. 1990-2003 Wyoming Benchmark Labor Force Estimates--Annual Averages*. Wyoming Department of Employment. Online at: <<<http://doe.state.wy.us/lmi/laus/9002aa.htm>>>
- WDEQ 2005. *Water Quality Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards, June 21, 2001*. Wyoming Department of Environmental Quality. Online at: <<http://deq.state.wy.us/wqd/surfacestandards/>>>
- WDEQ 2006. *Wyoming's 2006 305(b) State Water Quality Assessment Report and 2006 303(d) List of Waters Requiring TMDLs*. Cheyenne, Wyoming: Wyoming Department of Environmental Quality.
- WDOR 2003. *Excise Tax Division. Sales, use and lodging tax rates effective 10/1/2003*. Wyoming Department of Revenue. Online at: <<[HTTP://revenue.state.wy.us/contentroot/MapsPubs/salestax/MASTER_Rates_10-1-03.pdf](http://revenue.state.wy.us/contentroot/MapsPubs/salestax/MASTER_Rates_10-1-03.pdf)>>
- Weigel, J. F. 1987. "Sources of Hydrologic Data on Mesozoic Formations in the Upper Colorado River Basin and Comparison of Data Analysis Methods." pp. 71-80 in *Regional aquifer systems of the United States: aquifers of the western mountain area*, J.S. McLean and A. I. Johnson, eds. American Water Resource Association Mono. Ser. No. 14. 23rd Annual AWRA Conference and Symposium, November 1-6, 1987, Salt Lake City, Utah. 229pp.
- Weishampel, D. B. 1992. "Dinosaurian Distribution" in Weishampel, D. B., P. Dodson, and H. Osmolska, editors. *The Dinosauria*. Berkeley, California: University of California Press. pp. 63-139.
- Weiss, S. J., E. O. Otis, and O. E. Maughan 1998. "Spawning Ecology of Flannelmouth Sucker, *Catostomus latipinnis* (Catostomidae), in Two Small Tributaries of the Lower Colorado River." *Environmental Biology of Fishes* 52:419-433.
- Weitz, J. L., and J. D. Love 1952. *Geologic Map of Carbon County, Wyoming*. U.S. Geological Survey and Wyoming Geological Survey Map. Scale 1:160,000.
- Welder, G. E. and L. J. McGreevy 1966. *Groundwater Reconnaissance of the Great Divide and Washakie Basins and Some Adjacent Areas, Southwestern Wyoming*. U.S. Geological Survey, Hydrologic Investigations Atlas, HA-219.
- Wells, R. W., T. K. Dione, E. G. Knox, and R.W. Pols 1981. *Soil Inventory of the Overland Area, Wyoming* (2 vol.). Columbia, Maryland: Prepared for the Bureau of Land Management in Cooperation with the Soil Conservation Service. Soil and Land Use Tech. Inc.
- WGFD 1996. *Herd Unit Land Statistics*. Cheyenne, Wyoming: Wyoming Game and Fish Department, Biological Services Section.
- WGFD 1998. *Muddy Creek Basin Management Plan*. Cheyenne, Wyoming: Wyoming Game and Fish Department.

REFERENCES CITED

- WGFD 1999. *Atlas of Birds, Mammals, Reptiles and Amphibians in Wyoming*. Lander, Wyoming: Wyoming Game and Fish Department, Biological Services Section. 190pp.
- WGFD 2002. *2002 Harvest Information – 770, 2002 Deer*. Wyoming Game and Fish Department. Online at: <<<http://gf.state.wy.us/downloads/pdf/HarvestRpt/02BDeer.pdf>>> Accessed August 2005.
- WGFD 2003a. *Wildlife Observation System (WOS) Database Printout. T12-21N: R88-92W*. Cheyenne, Wyoming: Wyoming Game and Fish Department. November 17, 2003.
- WGFD 2003b. *Annual Big Game Yerd Unit Reports 2002*. Cheyenne, Wyoming: Wyoming Game and Fish Department, Green River Region. 349pp.
- WGFD 2004a. *Streams and Lakes Inventory Database*. Wyoming Game and Fish Department. Online at: <<<http://deq.state.wy.us/wqd/surfacestandards>>> August 20, 2004.
- WGFD 2004b. *Warmwater Stream Assessment Manual*. Cheyenne, Wyoming: Wyoming Game and Fish Department.
- WGFD 2004c. *Minimum Programmatic Standards Recommended by the Wyoming Game and Fish Department to Sustain Wildlife Habitats Affected by Oil and Gas Development*. Cheyenne, Wyoming: Wyoming Game and Fish Department.
- WGFD 2004d. *Minimum Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats on BLM Lands*. Wyoming Game and Fish Department. Cheyenne, Wyoming. This was the Oil and Gas Mitigation Working Group 2004. Blomquist.
- WGS 2003. *100 Years of Earthquakes (1871-1970)*. Wyoming Geological Survey. Online at: <<www.wsgsweb.uwyo.edu/coop.asp>> <<www.wrds.uwyo.edu/wrds/wsgs/hazards/quakes/quake.html>>
- Williams, V. 2001. Maintenance Department, Town of Wamsutter. Personal communication with George Blankenship, Blankenship Consulting LLC, April 16, 2001.
- Willis, J. 2000. Country Inn Motel, Baggs, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. June 7, 2000.
- Winterfeld, G. F. 1979. *Geology and Mammalian Paleontology of the Fort Union Formation, Eastern Rock Springs Uplift, Sweetwater County, Wyoming*. Laramie, Wyoming: University of Wyoming, Master's Thesis. 188 pp.
- Winterfeld, G. F. 1982. "Mammalian Paleontology of the Fort Union Formation (Paleocene), Eastern Rock Springs Uplift, Sweetwater County, Wyoming." *Contributions to Geology. The University of Wyoming* 21:73-111.
- Winward, A. H. 1993. Unpublished field trip notes by WGFD Region 4 Habitat personnel. Star Valley, Wyoming. September 2, 1993.
- Wischmeier, W. H., and D. D. Smith 1978. *Predicting Rainfall Rrosion Losses*. U.S. Department of Agriculture, Agricultural Research Service, Agriculture Handbook 537.

REFERENCES CITED

- WOGCC 1995 - 2000. 1995 - 1998. *Annual Statistical Summaries 1995 through 2000*. Wyoming Oil and Gas Conservation Commission Casper, WY.
- Wollmer, S. 1994. *Effects of Multiple Use on Rainsplash Erosion and Runoff in Semiarid Rangeland*. Thesis for Masters of Arts in Geography, San Francisco State University, California.
- Woolley T. 2003. Wyoming Game and Fish Department, Savery, Wyoming. Personal communication. October 13, 2003.
- Woolley, T. P., F. G. Lindzey, and R. Rothwell 1995. *Swift Fox Surveys in Wyoming: Annual Report*.
- WRCC 2003. *Meteorological data Collected at Baggs, Wyoming 1979-2000*. Western Regional Climate Center. Online at: <<<http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wybagg>>> Accessed in 2003.
- WRCC 2005. Historical Climate Information for Wyoming. Western Regional Climate Center. Online at: <<<http://www.wrcc.dri.edu/>>>
- WRDS 2002. *Surface Water Quality Analyses at Selected Sampling Stations*. Wyoming Water Resources Data System. Online at: <<<http://www.wrds.uwyo.edu>>>
- WRDS 2004. *Streamflow Measurements at Selected Gauging Stations*. Wyoming Water Resources Data System. Online at: <<<http://www.wrds.uwyo.edu>>>
- WSLUC 1979. *Wyoming State Land Use Plan*. Wyoming State Land Use Commission. 1979. 180 pp
- WTA 2002. *Wyoming Property Taxation 2002*. Cheyenne, Wyoming: Wyoming Taxpayers Association. December 2002.
- WTA 2003. *Wyoming Property Taxation 2003*. Cheyenne, Wyoming: Wyoming Taxpayers Association. December 2003.
- WWC 2006. *Technical Report for the Atlantic Rim Natural Gas Project, Groundwater Modeling of Impacts Associated with Coal Bed Natural Gas Development*. Prepared in support of the Atlantic Rim Natural Gas Project EIS, USDI-BLM, Rawlins Field Office. WWC Engineering.
- WYDOT 2000. *Highway Safety Program Vehicle Crash Data*. Wyoming Department of Transportation. August 22, 2000.
- WYDOT 2001. *Transportation planning program. Vehicle miles 2001*. Wyoming Department of Transportation.
- WYDOT 2002. *Highway safety program vehicle crash data*. Wyoming Department of Transportation. January 10, 2002.
- WYNDD 2003. *Data Compilation for T. Olson, for the Atlantic Rim Project Area, completed August 21, 2003*. Unpublished report. Laramie, Wyoming: Wyoming Natural Diversity Database, University of Wyoming.

REFERENCES CITED

Wyoming Business Council, Sweetwater County, Wamsutter Town, BAP America Production Company and local industries and Businesses 2002. *Town of Wamsutter Economic and Community Development Study*. Summer 2002.

Wyoming Weed and Pest Council 2006. Declared List of Weeds and Pests: Wyoming Weed and Pest Control Act of 1973 W.S. 11-5-102(a)(vii) and W.S. 11-5-102(a)(viii). November 2, 2006. Online at: <<http://wyoweed.org/>>>

Glossary

GLOSSARY

µg/L: Micrograms per liter, a unit of measure.

abandon: To cease producing oil or gas from a well when it becomes unprofitable. An exploration well may be abandoned after it has been proven nonproductive. Usually, some of the casing is removed and salvaged, and one or more cement plugs placed in the borehole to prevent migration of fluids between formations.

acre foot: A volume of water that covers an area of one acre to a depth of one foot (43,560 cubic feet or 325,851 gallons).

ad valorem: Levied according to assessed value.

affected environment: The biological, physical, and socioeconomic environment that will or may be changed by actions proposed and the relationship of people to that environment.

allotment: An area of land where one or more permittees graze their livestock. Generally consists of public land but may include parcels of private or State lands. The number of livestock and season of use are stipulated for each allotment. An allotment may consist of several pastures or be only one pasture.

alluvium: General term for debris deposited by streams on river beds, floodplains, and alluvial fans, especially deposits brought down during a flood. Applies to stream deposits of recent time. Does not include below water sediments of seas and lakes.

alternative: A combination of management prescriptions applied in specific amounts and locations to achieve a desired management emphasis or expressed in goals and objectives. One of several policies, plans, or projects proposed for decision making.

ambient: The environment as it exists at the point of measurement and against which changes or impacts are measured.

ambient air quality: The state of the atmosphere at ground-level as defined by the range of measured and/or predicted ambient concentrations of all significant pollutants for all averaging periods of interest.

ambient concentration: The mass of a pollutant in a given volume of air. It is typically measured as micrograms of pollutant per cubic meter of air.

ambient standards: The absolute maximum level of a pollutant allowed to protect either public health (primary) or welfare (secondary).

animal unit month (AUM): The amount of forage necessary for the sustenance of one cow/calf pair for 1 month.

anticline: An arched, inverted-trough configuration of folded and stratified rock layers.

Application for Permit to Drill (APD): The Department of Interior application permit form to authorize oil and gas drilling activities on federal land.

GLOSSARY

aquifer: A water-bearing bed or layer of permeable rock, sand, or gravel capable of yielding water, or the part of a water-driven reservoir that contains the aquifer.

Area of Critical Environmental Concern: An area that needs special management attention to preserve historic, cultural, or scenic values; to protect fish and wildlife resources or other natural systems or processes; or to protect life and provide safety from natural hazards.

artesian: Groundwater with sufficient pressure to flow without pumping.

assemblage: A group of rocks grouped together by age or similar origin.

background concentration: The existing levels of air pollutant concentration in a given region. In general, it includes natural and existing emission sources, but not future emission sources.

badland: Steep or very steep, commonly non-stony barren land dissected by many intermittent drainage channels. Badland is most common in semi-arid and arid regions where streams are entrenched in soft geologic material. Runoff potential is very high, and geologic erosion is active in such areas.

basin: A closed geologic structure in which the beds dip toward the center; the youngest rocks are at the center of a basin and are partly or completely ringed by progressively older rocks.

Best Available Control Technology (BACT): The best available air pollution control technology for a given emission source, considering environmental benefits, economic and energy costs, as defined by the applicable air quality regulatory authority.

big game: Those species of large mammals normally managed as a sport hunting resource.

borehole: A circular hole made by boring; especially a deep hole of small diameter, such as an oil well or a water well.

Bureau of Land Management (BLM): The Department of Interior agency responsible for managing most Federal Government subsurface minerals. It has surface management responsibility for Federal lands designated under the Federal Land Policy and Management Act of 1976.

canopy: The more-or-less continuous cover of branches and foliage formed collectively by the crown of adjacent trees and other woody growth.

carrying capacity: The ability of an area of land to sustain a species [generally livestock] over time without permanently degrading the land resources.

casing: Steel pipe placed in an oil or gas well to prevent the hole from collapsing.

completion: The activities and methods to prepare a well for production. Includes installation of equipment for production from an oil or gas well.

Condition of Approval (COA): Conditions or provisions (requirements) under which an Application for a Permit to Drill or a Sundry Notice is approved.

coniferous: Referring to a cone-bearing, usually evergreen, tree.

GLOSSARY

contrast: The effect of a striking difference in the form, line, color, or texture of the landscape features within the area being viewed.

Controlled Surface Use (CSU): Use or occupancy is allowed (unless restricted by another stipulation), but identified resource values require special operational constraints that may modify the lease rights. CSU is used for operating guidance, not as a substitute for the NSO or Timing stipulations.

corridor: A strip of land, usually a few to many times the width of a right-of-way through which one or more facilities (e.g. pipelines, roads, powerlines) may be located.

Council on Environmental Quality (CEQ): An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews Federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

criteria pollutants: Air pollutants for which the EPA has established State and National Ambient Air Quality Standards. These include particulate matter (PM₁₀), nitrogen oxides (NO_x), sulfur dioxide (SO₂), carbon monoxide (CO), and volatile organic compounds (VOC).

crucial range: Any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain itself at a certain level over the long-term.

cubic feet per second (cfs): The rate of discharge representing a volume of 1 cubic foot of water passing a given point during 1 second.

cubic foot: The volume of gas contained in one cubic foot of space at a standard pressure base of 14.7 psi and a standard temperature base of 60 degrees Fahrenheit.

cultural resources: The physical remains of human activity (artifacts, ruins, burial mounds, petroglyphs, etc.) and the conceptual content or context (as a setting for legendary, historic, or prehistoric events, such as a sacred area of native peoples, etc.) of an area of prehistoric or historic occupation.

cumulative impact: The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taken place over a period of time (40 CFR 1508.7).

deciduous: Trees or shrubs that lose their leaves each year during a cold or dry season.

decibel: A unit of measurement of noise intensity. The measurements are based on the energy of the sound waves and units are logarithmic. Changes of 5 decibels or more are normally discernible to the human ear.

development well: A well drilled in proven territory (usually within 1 mile of an existing well).

directional drilling: The intentional deviation of a wellbore from vertical to reach subsurface areas off to one side from the drilling site.

GLOSSARY

discharge: The volume of water flowing past a point per unit time, commonly expressed as cubic feet per second (cfs), gallons per minute (gpm), or million gallons per day (mgd).

dispersion: The spreading out of pollutants. Generally, used to show how much an air pollutant will spread from a particular point.

displacement: As applied to wildlife, forced shifts in the patterns of wildlife use, either in location or timing of use.

disposal well: A well into which produced water from other wells is injected into an underground formation for disposal.

dissolved solids: The total amount of dissolved material, organic and inorganic, contained in water or wastes.

disturbance: An event that changes the local environment by removing organisms or opening up an area, facilitating colonization by new, often different, organisms.

disturbed area: Area where natural vegetation and soils have been removed or disrupted.

diversity: The distribution and abundance of different plant and animal communities and species within the area covered by a Land and Resource Management Plan.

drainage: Natural channel through which water flows some time of the year. Natural and artificial means for effecting discharge of water as by a system of surface and subsurface passages.

drill bit: The cutting device used to drill a well. It is typically made of hardened steel, and may have industrial grade diamond components.

drilling mud: The circulating fluid used to bring cuttings out of the well bore, cool the drill bit, and provide hole stability and pressure control. Drilling mud includes a number of additives to maintain the mud at desired viscosities and weights. Some additives that may be used are caustic, toxic, or acidic.

drill pad: Relatively flat work area that contains equipment and facilities used for well drilling and well completion.

drill pipe: The heavy seamless tubing used to rotate the drill bit and circulate the drilling fluid. The standard drill pipe section is 30 feet long (a joint).

drill rig: The mast, draw works, and attendant surface equipment of a drilling workover unit.

dry hole: Any well incapable of producing oil or gas in commercial quantities. A dry hole may produce water, gas or even oil, but not enough to justify production.

earthquake: Sudden movement of the earth's crust resulting from faulting, volcanism, or other mechanisms.

ecosystem: An interacting system of organisms considered together with their environment for example, marsh, watershed, and stream ecosystems.

GLOSSARY

effects: These include: a) Direct effects, which are caused by the action and occur at the same time and place; b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative.

Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (40 CFR 1508.8).

emergent vegetation: Erect, rooted, herbaceous plants that project out of the water, or "emerge."

emission factor: An empirically derived mathematical relationship between pollutant emission rate and some characteristic of the source such as volume, area, mass, or process output.

endangered species (animal): Any animal species in danger of extinction throughout all or a significant portion of its range. This definition excludes species of insects that the Secretary of the Interior determines to be pests and whose protection under the Endangered Species Act of 1973 would present an overwhelming and overriding risk to man.

endangered species (plant): Species of plants in danger of extinction throughout all or a significant portion of their ranges. Existence may be endangered because of the destruction, drastic change, or severe curtailment of habitat, or because of over exploitation, disease, predation, or even unknown reasons. Plant taxa from very limited areas (e.g., the type localities only), or from restricted fragile habitats usually are considered endangered.

endemic: Confined naturally to a particular geographic area. Often used in opposition to the work epidemic.

environment: The aggregate of physical, biological, economic, and social factors affecting organisms in an area.

environmental assessment (EA): An investigation of a proposed action and alternatives to that action and their direct, indirect, and cumulative environmental impacts; the process which provides the necessary information for reaching an informed decision and the information needed for determining whether a proposed action may have significant environmental effects and determining the type of environmental documents required.

environmental impact statement (EIS): An analysis of alternative actions and their predictable environmental effects, including physical, biological, economic, and social consequences and their interactions; short- and long-term effects; direct, indirect, and cumulative effects.

ephemeral drainage: A drainage area or a stream that has no base flow. Water flows for a short time each year but only in direct response to rainfall or snowmelt events.

GLOSSARY

ephemeral stream: A stream that flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice and which has a channel bottom that is always above the local water table.

emission: Air pollution discharge into the atmosphere, usually specified by mass per unit time.

erosion: The removal, detachment, and entrainment of earth materials by weathering, dissolution, abrasion, and corrosion, later to be transported by moving water, wind, gravity, or glaciers.

exploration: The search for economic deposits of minerals, ore, and other materials through practices of geology, geochemistry, geophysics, drilling, and/or mapping.

exploration well: A well drilled in an area where there is no oil or gas production.

fault: A fracture in bedrock along which there has been vertical and/or horizontal movement caused by differential forces in the earth's crust.

federal lands: All lands and interests in lands owned by the U.S. that are subject to the mineral leasing laws, including mineral resources or mineral estates reserved to the U.S. in the conveyance of a surface or non-mineral estate.

fisheries: Streams and lakes used for fishing.

floodplain: That portion of a river valley, adjacent to the channel, which is built of recently deposited sediments and is covered with water when the river overflows its banks at flood stages.

fluvial: Comprehensive term for river processes.

footprint: The actual surface area physically disturbed by oil and gas operations and ancillary facilities.

forage: Vegetation of all forms available for animal consumption.

forb: A broad-leaved flowering herb other than grass.

formation (Geologic): A rocky body distinguishable from other rock bodies and useful for mapping or description. Formations may be combined into groups or subdivided into members.

fugitive dust: Airborne particles emitted from any source other than through a controllable stack or vent.

functional value: A term that refers to the various functions performed by wetlands and the values people place on those functions. Functions are the chemical, physical, and biological processes or attributes of a wetland without regard to their importance to society. They include groundwater recharge and discharge, sediment trapping, nutrient/pollutant retention and removal, shoreline anchoring and dissipation of erosive forces, food chain support, wildlife and fish habitat, and heritage value (including active and passive recreation, uniqueness, etc.).

game species: Animals commonly hunted for food or sport.

GLOSSARY

gpd/ft: Gallons per day per foot.

gpm: Gallons per minute.

grade: A slope stated in terms of feet per mile or as feet per feet (percent); the content of precious metal per volume of rock (ounces per ton).

groundwater: Water contained in the pore spaces of consolidated and unconsolidated surface material.

habitat: A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

habitat function: The arrangement of habitat features, and the capability of those features to sustain species, populations, and diversity of wildlife over time.

habitat type: The aggregate of all areas that support or can support the same primary vegetation at climax.

hazardous waste: (A) Any substitute designated pursuant to section 311(b)(2)(A) of the Federal Water Pollution Control Act. (B) Any element, compound, mixture, solution, or substance designated pursuant to section 102 of this Act. (C) Any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act (but not including any waste the regulation of which under the Solid Waste Disposal Act has been suspended by Act of Congress). (D) Any toxic pollutant listed under section 307(a) of the Federal Water Pollution Control Act. (E) Any hazardous air pollutant listed under section 112 of the Clean Air Act. (F) Any imminently hazardous chemical substance or mixture with respect to which the Administrator has taken action pursuant to section 7 of the Toxic Substances Control Act. The term does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).

herbaceous: The plant strata which contain soft, not woody, stemmed plants that die to the ground in winter.

hydric soils: A soil that is saturated, flooded, or ponded with water long enough during the growing season (i.e., soil temperature of 41°F at 20 inches depth) to develop anaerobic soil conditions (i.e., reduced oxygen levels). These soils develop characteristics that are indicative of the wet and anaerobic conditions. Such characteristics may include an undecomposed organic surface layer (histic epipedon), surface horizons with low chromas (i.e., very dark brown to black), organic staining and streaking, grey-colored layers of horizons, iron concretions, and/or light grey- or rust-colored mottles or specks of highly contrasting color. These characteristics must generally occur within 50 percent of the root zone.

hydrology: A science that deals with the properties, distribution, and circulation of surface and subsurface water.

GLOSSARY

hydrophytic plants: Those species which either require or tolerate wet or saturated soils and are therefore indicative of these conditions. Vegetation is a good indicator of the physical conditions on a given site. Such conditions include soil moisture.

hydrostatic testing: Testing of the integrity of a newly placed, but uncovered pipeline for leaks. The pipeline is filled with water and pressurized to operating pressures, and the pipeline is visually inspected.

impact: The results of an action on the environment; the impact may be primary (direct) or secondary (indirect); the term impact is synonymous with effect according to 40 CFR 1508.8.

infiltration: The movement of water or some other liquid into the soil or rock through pores or other openings.

infrastructure: The basic framework or underlying foundation of a community including road networks, electric and gas distribution, water and sanitation services, and facilities.

injection well: A well used to inject fluids into an underground formation to increase reservoir pressure.

interdisciplinary team (IDT): A group selected to work within the NEPA process in scoping, analysis, and document preparation. The purpose of the team is to integrate its collective knowledge of the physical, biological, economic, and social sciences and the environmental design arts into the environmental analysis process. Interaction among team members often provides insight that otherwise would not be apparent.

intermittent stream: A stream or reach of a stream that drains a watershed of at least one square mile; or a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and groundwater discharge.

jurisdictional wetlands: "Those wetlands which are within the extent of COE regulatory overview" (33 CFR 328.1 and (2)). For an area to be identified as a jurisdictional wetland, the area must exhibit positive indicators of wetland hydrology, hydrophytic vegetation, and hydric soils. Those areas that do not meet the three parameters are uplands or non-jurisdictional wetlands. The Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) describes technical criteria for determining hydrophytic vegetation, hydric soils, and wetland hydrology, and therefore the occurrence of jurisdictional wetlands.

kg/ha-yr: Kilograms per hectare per year, a unit of measure.

km: Kilometers, a unit of measure.

landform: Any physical, recognizable form or feature of the Earth's surface, having a characteristic shape and produced by natural causes. Includes major features such as plains, plateaus, and mountains, and minor features, such as hills, valleys, slopes, canyons, arroyos, and alluvial fans.

landscape character: The arrangement of a particular landscape as formed by the variety and intensity of the landscape features as defined as the four basic elements (form, line, color, and texture). These factors give the area a quality that distinguishes it from its immediate surroundings.

GLOSSARY

landslide: A perceptible downhill sliding or falling of a mass of soil and rock lubricated by moisture or snow.

land use: Land uses determined for a given area that establish the types of activities allowed (e.g., mining, agriculture, timber production, residential, industrial).

lead agency: The agency or agencies preparing or having taken primary responsibility for preparing the environmental impact statement (40 CFR 1508.16).

lease: (1) A legal document that conveys to an operator the right to drill for oil and gas. (2) The tract of land on which a lease has been obtained, where producing wells and production equipment are located.

leasable minerals: Federal minerals subject to lease under the Mineral Leasing Act of 1920, as amended, and supplemented. Includes minerals, such as oil, gas, coal, geothermal, tar sands, oil shale, potassium, phosphate, sodium, asphaltic materials.

lek: An assembly area for communal courtship display, usually in reference to greater sage-grouse or other grouse.

lithic scatter: A surface scatter of cultural artifacts and debris that consists entirely of lithic (i.e., stone) tools and chipped stone debris. This is a common prehistoric site type that is contrasted to a cultural material scatter, which contains other or additional artifact types such as pottery or bone artifacts, to a camp which contains habitation features, such as hearths, storage features or occupation features, or to other site types that contain different artifacts or features.

loam: A mixture of sand, silt, and clay containing between 7 and 27 percent clay, 28 to 50 percent silt and less than 50 percent sand.

management area: An area composed of aggregate pieces of land (generally several to many analysis areas) to which a given management objective and prescriptions are applied.

management direction: A statement of multiple use and other goals and objectives, along with the associated management prescriptions and standards and guidelines to direct resource management.

meq/L: Milliequivalents per liter, a unit of measure.

mesic area: A habitat having a moderate amount of moisture available for the support of plant life.

methane (CH₄): The simplest hydrocarbon; natural gas is nearly pure methane.

micromhos: A measure of electrical conductance.

mineral rights: Reserved mineral rights are the retention of ownership of all or part of the mineral rights by a person or party conveying land to the United States. Conditions for exercising these rights have been defined in the Secretary's "Rules and Regulations to Govern Exercising of Mineral Rights Reserved in Conveyances to the United States" attached to and made a part of deeds reserving mineral rights.

GLOSSARY

mitigate: To lessen the severity.

mitigation: Avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree of magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and/or compensating for the impact by replacing or providing substitute resources or environments.

mL: Micro liter, a unit of measure.

modeling: A mathematical or physical representation of an observable situation. In air pollution control, models afford the ability to predict pollutant distribution or dispersion from identified sources for specified weather conditions.

monitor: To systematically and repeatedly watch, observe, or measure environmental conditions in order to track changes.

National Ambient Air Quality Standards (NAAQS): The allowable concentrations of air pollutants in the air specified by the Federal government. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants).

National Environmental Policy Act (NEPA): The federal law established in 1969, which went into effect on January 1, 1970, that (1) established a national policy for the environment, (2) requires federal agencies to become aware of the environmental ramifications of their proposed actions, (3) requires full disclosure to the public of proposed federal actions and a mechanism for public input into the federal decision-making process, and (4) requires federal agencies to prepare an environmental impact statement for every major action that would significantly affect the quality of the human environment.

National Register of Historic Places: A list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture.

native species: Plants that originated in the area in which they are found, i.e., they naturally occur in that area.

natural gas: Those hydrocarbons, other than oil and other than natural gas liquids separated from natural gas, that occur naturally in the gaseous phase in the reservoir and are produced and recovered at the wellhead in gaseous form. Natural gas includes coal bed methane gas.

No Action Alternative: The management direction, activities, outputs, and effects that are likely to exist in the future if the current plan would continue unchanged.

Notice of Staking: Prior to filing a complete Application for Permit to Drill (APD) an Operator may wish to file a Notice of Staking (NOS). Under this procedure, the site is surveyed and staked, and the onsite inspection is used to provide information to the Operator prior to the Operator committing time and money in preparing an APD which might not reflect agency concerns.

GLOSSARY

noxious weeds: Officially designated undesirable or invading weedy species generally introduced into an area due to human activity.

OUT: A designation for non-use areas, which are areas that contain habitats of limited or no importance to big game species.

ozone: A molecule containing three oxygen atoms (O_3) produced by passage of an electrical spark through air or oxygen (O_2).

paleontology: The science that deals with the history and evolution of life on earth.

parent materials: Unconsolidated material formed from bedrock which undergoes further changes to form soil.

particulate matter: A particle of soil or liquid matter (e.g., soot, dust, aerosols, fumes and mist).

pCi/L: Picocuries per liter, a unit of measure.

perennial stream: A stream or reach of a stream that flows throughout the year.

permeability: Extent that a substance is open to passage or penetration, especially by fluids.

permittee (grazing): A person who has livestock grazing privileges on an allotment or allotments within the resource area.

pH: The negative $\log_{10}$ of the hydrogen ion activity in solution; a measure of acidity or basicity of a solution.

playa: The shallow central basin of a desert plain, in which water gathers after a rain and is evaporated.

preferred alternative: The alternative identified in the EIS as the action favored by the agency.

prevailing wind: The most frequent compass direction from which the wind blows.

prevention of significant deterioration of air quality (PSD): A classification established to preserve, protect, and enhance the air quality in National Wilderness Preservation System areas in existence prior to August 1977 and other areas of National significance, while ensuring economic growth can occur in a manner consistent with the preservation of existing clean air resources. Specific emission limitations and other measures, by class, are detailed in the Clean Air Act (42 U.S.C. 1875 et 15q.).

produced water: Formation water pumped during the development of a gas well.

PSD increments: The maximum allowable increase in pollutant concentrations permitted over baseline conditions as specified in the EPA Prevention of Significant Deterioration (PSD) regulations (40 CFR Part 52.21). The regulations apply only to area currently attaining NAAQS/WAAQS. Most National Parks and Wilderness areas are Class I Areas, where almost no future pollution increase is permitted. Most other areas are Class II Areas, where moderate increases in pollution levels are allowed.

GLOSSARY

public land: Lands or interests in lands owned by the United States and administered by the Secretary of Interior through the Bureau of Land Management, without regard to how the United States acquired ownership.

range: Land producing native forage for animal consumption and lands that are revegetated naturally or artificially to provide forage cover that is managed like native vegetation, which are amenable to certain range management principles or practices.

raptor: Living on prey; a group of carnivorous birds consisting of hawks, eagles, falcons, kites, vultures, and owls.

reclamation: rehabilitation of a disturbed area to make it acceptable for designated uses. This normally involves regrading, replacement of topsoil, revegetation and other work necessary to restore it for use.

record of decision (ROD): A decision document for an Environmental Impact Statement or Supplemental EIS that publicly and officially discloses the responsible official's decision regarding the actions proposed in the EIS and their implementation.

reserve pit: (1) Usually an excavated pit that may be lined with plastic, which holds drill cuttings and waste mud. (2) Term for the pit which holds the drilling mud.

reserves: Identified resources of mineral-bearing rock from which the mineral can be extracted profitably with existing technology and under present economic conditions.

revegetation: The re-establishment and development of self-sustaining plant cover. On disturbed sites, human assistance will speed natural processes by seed bed preparation, reseeding and mulching.

right-of-way (ROW): The legal right for use, occupancy, or access across land or water areas for a specified purpose or purposes.

riparian: Land areas which are directly influenced by water. They usually have visible vegetative or physical characteristics showing this water influence. Streamsides, lake borders, or marshes are typical of riparian areas.

runoff: That part of precipitation that appears in surface streams. Precipitation that is not retained on the site where it falls and is not absorbed by the soil.

salinity: A measure of the amount of mineral substances dissolved in water.

scatter (archeological): Random evidence of prior disturbance that is distributed about an area rather than concentrated in a single location.

scoping: An early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action. Scoping may involve public meetings, field interviews with representatives of agencies and interest groups, discussions with resource specialists and managers, and written comments in response to news releases, direct mailings, and articles about the proposed action and scoping meetings.

GLOSSARY

sediment: Soil or mineral transported by moving water, wind, gravity, or glaciers, and deposited in streams or other bodies of water, or on land.

sediment load: The amount of sediment (sand, silt, and fine particles) carried by a stream or river.

sedimentary: Rock formed from fragments of pre-existing rocks (e.g. sandstone) or by precipitation from solution (e.g. limestone).

seismic: Pertaining to an earthquake or earth vibration, including those that are artificially induced.

seismic operations: Use of explosive or mechanical thumpers to generate shock waves that can be read by special equipment to indicate subsurface conditions.

sensitive species: Those species of plants or animals that have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species under the Endangered Species Act. This also includes species that are on an official state list or are recognized by the Land Manager as needing special management to prevent their being placed on federal or state lists.

sensitivity level: A particular degree or measure of viewer interest in the scenic qualities of the landscape.

shallow coal seam: Those coal seams that are too shallow to drill to directionally given the area geology and spacing limitations.

shut in: To close the valves on a well so it ceases production.

significant impact: A meaningful standard to which an action may impact the environment. The impact may be beneficial, adverse, direct, indirect, or cumulative, and may have short-term or long-term effects.

silt: Any earthy material composed of fine particles, smaller than sand but larger than clay, suspended in or deposited by water.

soil: Loose, unconsolidated surface material comprising topsoil and subsoil.

spawning: The deposition of eggs and sperm by fish.

species: (1) The classification level of biological nomenclature which categorized each group of related organisms potentially capable of interbreeding; (2) the accepted level of classification to differentiate one specific type of organism from another.

species of concern: Species of concern include federally listed threatened or endangered species, species proposed for listing, BLM sensitive species, and species considered rare or important by the Wyoming Natural Diversity Database (WYNDD).

spp.: An abbreviation for the plural of species.

spud: Begin drilling a well.

GLOSSARY

sq.mi.: Square mile.

stipulation: A legal requirement, specifically a requirement that is part of the terms of a mineral lease. Some stipulations are standard on all federal leases. Other stipulations may be applied to the lease at the discretion of the surface management agency to protect valuable surface resources.

strata: An identifiable layer of bedrock or sediment; does not imply a particular thickness of rock.

s.u.: Standard units, a unit of measure.

substrate: Material consisting of silts, sands, gravels, boulder and woody debris found on the bottom of a stream channel.

surface lands: Lands consisting of the outside part of the solid earth or ocean as contrasted with subsurface or below surface land use(s) such as drilling and mixing.

threatened and endangered species: Any species, plant or animal, which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Threatened species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act.

topography: The features of the earth, including relief, vegetation, and waters.

topsoil: The uppermost layers of naturally occurring soils suitable for use as a plant growth medium.

total dissolved solids (TDS): Total amount of dissolved material, organic or inorganic, contained in a sample of water.

turbidity: A fisheries measurement of the total suspended solids in water expressed as nephelometric turbidity units (NTU).

usable water: Defined by Onshore Oil and Gas Order No. 2 as groundwater with a TDS of 10,000 ppm or less encountered at any depth.

vegetation: All of the plants growing in and characterizing a specific area or region; the combination of different plant communities found there.

vegetation type: A plant community with visually distinguishable characteristics, named for the apparent dominant species.

viewshed: Landscape that can be directly seen under favorable atmospheric conditions, from a viewpoint or along a transportation corridor.

visibility: A measurement of the maximum distance to which large objects may be viewed. Fixed reference objects such as mountains, hills, towers, or buildings are normally used to estimate visibility.

visual range: The distance at which a black object (in practice, a distant mountain) becomes indistinguishable to an observer.

GLOSSARY

visual resource: The composite of basic terrain, geologic features, water features, vegetation patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for viewers.

Visual Resource Management (VRM): A system of visual management used by the BLM. The program has a dual purpose, to manage the quality of the visual environment and to reduce the visual impact of development activities while maintaining effectiveness in all Bureau resource programs. VRM also identifies scenic areas that warrant protection through special management attention. The system uses five classes for categorizing visual resources.

Class 1 - Natural ecological changes and very limited management activity are allowed. Any contrasts created within the characteristic landscape must not attract attention. This classification is applied to wilderness areas, wild and scenic rivers, and other similar situations.

Class 2 - Changes in any of the basic elements (form line, color, texture) caused by a management activity should not be evident in the characteristic landscape. Contrasts are seen, but must not attract attention.

Class 3 - Contrasts to the basic elements caused by a management activity are evident, but should remain subordinate to the existing landscape.

Class 4 - Any contrast attracts attention and is a dominant feature of the landscape in terms of scale, but it should repeat the form, line, color and texture of the characteristic landscape.

Class 5 - The classification is applied to areas where the natural character of the landscape has been disturbed to a point where rehabilitation is needed to bring it up to one of the four other classifications. The classification also applies to areas where unacceptable cultural modification has lowered scenic quality; it is often used as an interim classification until objectives of another class can be reached.

water bar: A ridge made across a hill to divert water to one side.

water quality: Refers to a set of chemical, physical, or biological characteristics that describe the condition of a river, stream, or lake. The quality of water determines which beneficial uses it can support. Different instream conditions or levels of water quality are needed to support different beneficial uses.

Waters of the United States: A jurisdictional term from Section 404 of the Clean Water Act referring to water bodies such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce.

watershed: A topographically delineated area that is drained by a stream system, that is, the total land area above some point on a stream or river that drains past that point.

wellbore: The diameter of the hole to be drilled.

well head: The equipment used to maintain surface control of a well. It is composed of the casing head, tubing head and a series of valves and fittings.

GLOSSARY

well pad: Relatively flat work area that contains equipment and facilities used for oil/gas production.

wetlands: Areas that are inundated by surface or groundwater with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

Wilderness Study Area (WSA): An area determined to have wilderness characteristics. WSAs are submitted to the President and Congress for wilderness designation. These areas are an interim designation, valid until either designated as wilderness or released to multiple-use management.

wind rose: Any one of a class of diagrams designed to illustrate the distribution of wind direction experienced at a given location over a given period of time. Wind roses may also give information concerning distribution of wind speed, stability, or other meteorological parameters.

winter range: The place where migratory (and sometimes non-migratory) animals congregate during the winter season.

workover: Well maintenance activities that require onsite mobilization of a drill rig to repair the well bore equipment (casing, tubing, rods, or pumps) or the wellhead. In some cases, a workover may involve development activities to improve production from the target formation.

